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The Superiority of the South African Negro or Bantu as a Parturient

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PART I.—THE SIZE OF THE BANTU HEAD AT BIRTH.*

THE Bantu female pelvis has been compared with that of the Bantu male.[1] In comparing the female pelvic girdle of different racial groups, it is of value to know the relative size of the foetus for the respective races. For this reason an analysis of the gross birth-weight in over 2,000 cases was published;[2] but it is obvious that birth-weight would vary with good or poor nutrition during intrauterine life, probably in the main owing to the quantity of subcutaneous fat laid down in the foetus. While the mean Bantu weight was about $6\frac{3}{4}$ pounds, the mean in a smaller series receiving good antenatal care was $7\frac{1}{4}$ pounds, a near approach to the average for any prosperous European community. It is, therefore, of importance to assess the size of the head in the Bantu newborn, for this is the biggest part of the foetus to pass through the birth canal. The correlation table (Table I) demonstrates that in the newborn there is not a very marked relation between weight and the area of a cross-section in the plane of the occipito-frontal and biparietal diameters of the skull.

*This paper was presented as Appendix 3 of a D.Sc. Thesis submitted to the University of the Witwatersrand, South Africa.

Measurement was carried out on 500 heads of which two-thirds were Natal Zulu, one-fifth Basuto, and the rest Xhosa, Swazi, and Mpondo. Males and females were taken at random, and no separate analysis is shown for the sexes.

The birth-weight was observed in all cases, and on the day of birth the following head diameters were measured: the occipito-frontal, biparietal, suboccipito-bregmatic, and mentovertical. Areas were calculated to represent a cross-section of the greatest part, as it traverses the pelvis, of (*a*) the well-flexed head (biparietal and suboccipito-bregmatic as axes), and (*b*) the deflexed head (biparietal and occipito-frontal as axes). The correlation coefficient and regression equation for weight and area were calculated.

The measurements considered are those of the vault of the cranium, because the latter forms the major portion of the skull. In the full-time foetus the face, mandible, and temporal bones are small, the size of the head depending on the four large squamous bones, that is, the two parietal, the frontal, and the occipital.

Mean birth-weight. For 500 babies ranging in weight between 60 ounces (3 pounds, 12 ounces), and 178 ounces (11 pounds, 2 ounces), the mean weight was

112.13 ± 0.71 ounces, standard deviation 15.83 ounces, and coefficient of variation 14.1 per cent. This weight averaged approximately ¼ pound more than that of the larger series[1] referred to above. Only 7 babies weighed were under 5 pounds, their occipito-frontal-biparietal plane areas varying between 65 and 80 sq. cm.; 5 corresponding areas of heavier babies were below 65 sq. cm.

TABLE I.
Bantu Newborn.

Correlation table for birth-weight and the area of a cross-section in the plane of the occipito-frontal and biparietal diameters of the skull.

Head area (sq. cm.)	Birth-weight in pounds									Total
	3	4	5	6	7	8	9	10	11	
60	–	–	2	3	–	–	–	–	–	5
65	1	1	6	11	8	2	–	–	–	29
70	–	2	15	36	22	1	–	–	–	76
75	–	3	12	60	30	11	3	–	–	119
80	–	–	11	59	48	16	1	1	–	136
85	–	–	4	32	40	17	5	–	–	98
90	–	–	1	5	11	7	2	–	–	26
95	–	–	–	2	4	1	1	–	–	8
100	–	–	–	–	1	–	–	–	–	1
105	–	–	–	–	1	–	–	–	–	1
110	–	–	–	–	–	–	–	–	1	1
Total	1	6	51	208	165	55	12	1	1	500

Correlation coefficient + 0.364 ± 0.045

Occipito-frontal diameter. The mean length of this diameter was 11.30 ± 0.03 cm., range 9.75 to 13.5 cm., standard deviation 0.64 cm., and coefficient of variation 5.67 per cent. Moulding during parturition may increase or decrease this diameter, usually with a corresponding inverse change in both suboccipito-bregmatic and biparietal diameters.

Scammon and Calkins[3] give a list of authors who have published average values for this diameter. Unfortunately Scammon and Calkins measured from glabella to inion, whereas the Bantu diameter was the greatest distance between occipital and frontal bones. The latter is the measurement of practical value, and one which can be taken accurately in all cases; moreover, Williams[4] and De Lee[5] recommended these termini for the diameter. As the last-mentioned authorities are found in the Scammon and Calkins[3] list of 25 other authors, it may be assumed that some of the authors measured the diameter in the manner used for the Bantu. In 12 of the 25 series the mean was less than that for the Bantu, and in 1 equal to the Bantu mean. De Lee[5] who states that his figure is based on a large number of measurements showed an average of 11 cm., Williams[6] a corresponding mean of 11.75 cm.

The mean occipito-frontal diameter in the Bantu may, therefore, be claimed to correspond with that found for Europeans.

Suboccipito-bregmatic diameter. With a range for this diameter of 7.25 to 12 cm., the mean was 9.68 ± 0.03 cm., standard deviation 0.63 cm., and coefficient of variation 6.50 per cent.

Scammon and Calkins[3] give a list of 17 observers publishing averages for this

diameter, and of these 8 found figures lower than the Bantu mean of 9.68 cm.

Biparietal diameter. This is the greatest width of the head between the parietal eminences. The figures for the biparietal diameter were as follows: mean 9.22 ± 0.02 cm., standard deviation 0.53 cm., coefficient of variation 5.74 per cent, and range 7.5 to 10.75 cm.

Scammon and Calkins[3] cite 47 series from 38 authors who publish means for the biparietal diameter: in 15 series the means are smaller than that for the Bantu. Both De Lee[5] and Williams[6] show a mean of 9.25 cm. as compared with 9.22 cm. for the Bantu mean biparietal diameter.

If the area of a cross-section of the head with biparietal and occipito-frontal as axis is calculated from the means of these diameters, it is found that the Bantu area is greater than that for Scammon and Calkins[3] and De Lee,[5] but slightly less than that for Williams.[6].

Mentovertical diameter. For 475 heads with a range for this diameter of 11 to 15.5 cm., the mean was 13.27 ± 0.03 cm., standard deviation 0.74 cm., and coefficient of variation 5.48 per cent. The measurement was made from the point of the chin to the most distant point on the vertex (parietal bone). Scammon and Calkins define the posterior point of this diameter as the external occipital protuberance, as in the case of their occipito-frontal diameter. From the table of authors presented by Scammon and Calkins,[3] comparison with the Bantu mean for the mentovertical diameter shows that in 15 series out of 34 the mean diameters were less than that of the Bantu. The Bantu figures lay midway between those of De Lee (13 cm.) and Williams (13.5 cm.).

Area of cross-section with biparietal and suboccipito-bregmatic diameters as axes. For 500 areas calculated from the ellipse formula, the range was 50.2 to 99.3 sq. cm., the mean 68.64 ± 0.28 sq. cm., standard deviation 6.33 sq. cm., and coefficient of variation 9.23 per cent. Only 7 areas were below 55 sq. cm. and 3 above 85 sq. cm., the deviations inside this range being uniformly distributed.

In English obstetric teaching the diameters under consideration are given as $3\frac{3}{4}$ inches each. This would give an area of 71.3 sq. cm. Although such a difference from the Bantu might be significant, both de Lee's and Williams' series give an area calculated from mean diameters which is less than the corresponding Bantu area.

The correlation between birth-weight and this area is shown in Table II. The coefficient of correlation between these dimensions was found to be +0.323 ± 0.045, and being 7.2 times its standard error it is highly significant. The regression equation for the line was found to be

$$W = 0.05045A + 3.545 \text{ where}$$

W = weight in pounds

and A = area in sq. cm.

$$Sw = \sigma w \sqrt{1 - 1^2}$$

$$= 0.936 \text{ pounds.}$$

As an approximation it may be said that the weight of the foetus is equal to the sum of 1/20 of the area and $3\frac{1}{2}$ lb. The error of prediction in using this equation is about 15 ounces.

Area of cross-section with biparietal and occipito-frontal diameters as axes. The range in 500 calculated areas was 62.0 to 112.7 sq. cm. with a mean of 80.64 ± 0.32 sq. cm., standard deviation 7.24 sq. cm., and coefficient of variation 8.97 per cent. Five areas only were below 65 sq. cm. and 3 above 100 sq. cm.

The correlation between birth-weight and the biparietal × occipito-frontal area is shown in Table I. The coefficient of correlation between these dimensions was found to be +0.364 ± 0.045. This coefficient is more than 8 times its standard error, and may be accepted as being certainly signifi-

TABLE II.
Bantu Newborn.

Correlation table for birth-weight and the area of a cross-section in the plane of the suboccipito-bregmatic and biparietal diameters of the skull.

Head area (sq. cm.)	Birth-weight in pounds									Total
	3	4	5	6	7	8	9	10	11	
50	–	–	3	4	–	–	–	–	–	7
55	1	1	5	11	7	3	–	–	–	28
60	–	1	18	53	22	7	1	–	–	102
65	–	2	9	67	54	16	2	–	–	150
70	–	2	12	62	62	18	3	–	–	159
75	–	–	1	10	9	7	2	–	–	29
80	–	–	1	3	10	3	4	1	–	22
85	–	–	–	–	1	1	–	–	–	2
90	–	–	–	–	–	–	–	–	–	–
95	–	–	–	–	–	–	–	–	1	1
Total	1	6	49	210	165	55	12	1	1	500

Correlation coefficient + 0.323 ± 0.045

cant. The relationship between weight and area is a rectilinear one, and the regression equation for the line was found to be

$$W = 0.04975A + 2.988 \text{ where}$$

W = weight in pounds

and A = area in sq. cm.

$$Sw = \sigma w \sqrt{1 - r^2}$$

$$= 0.921 \text{ pounds}$$

The standard error for this equation is thus 0.921 lb., i.e. the standard error of prediction in using the equation is $14\frac{3}{4}$ ounces.

CONCLUSION.

From the data here reported on the dimensions of the head at birth, it must be concluded that the difference between Bantu and European foetal heads at term is not considerable. While there is great variability between the Bantu and certain European figures, many of the latter are smaller than the Bantu averages. Evidence has not been found to prove that the Bantu newborn has a smaller head than the European at birth.

Note on the correlation tables. It is of great value for the obstetrician to observe the relationship that exists between foetal weight and the size of the foetal head. The general impression is that a relatively large foetus has a relatively large head; and if disproportion is being estimated, the size of the foetus as judged by palpation is recognized to be an important factor. This view is sound in many cases, but the correlation tables demonstrate that a small foetus may have an unexpectedly large head and thus be responsible for serious obstetrical errors. Conversely, but with less danger, unnecessarily radical treatment may be adopted because a foetus which is estimated to be large has a relatively small head.

In the tables presented only birth-weights are considered, and the size of the head is based on the areas of cross-sections of the head in two different planes. It will be observed that:

1. Fifteen babies weigh under 6 lb. and still have the greater area between 75 and 80 sq. cm., the mean for this area being 80.64 sq. cm. Similarly, 11 babies weigh under 6 lb. and have a lesser area of 65 to 70 sq. cm., whereas the mean for this area is 68.64 sq. cm.

2. Conversely, there are 17 babies

weighing over 8 lb. which have the greater area below the average, and 11 babies weighing over 8 lb. have the lesser area below 65 sq. cm.

3. One baby weighing 10 to 11 lb. has a "greater head area" which is equal to the mean.

Two babies weighing only 4 to 5 lb. have the "lesser head area" greater than the mean.

4. Babies weighing 9 lb. show a range of the lesser area between 60 and 85 sq. cm., and a range of the greater area between 75 and 100 sq. cm. A range of the same order is seen to occur for most of the other weight groups.

The conclusion drawn from the correlation tables is that at term there is a well marked relationship between foetal weight and the size of the foetal head. There are important exceptions, however, in which a small baby may have a big head and vice versa. And it is these exceptional cases that are of importance to the clinician. When the obstetrician uses his skill in assessing foetal proportions in a case of disproportion, he must be armed, therefore, with the knowledge that head and body size may not be proportional.

Part II.—An Assessment of Pelvic Capacity as a Cause of Dystocia in the South African Negro or Bantu.

Introduction.

Some Observations on Labour in the South African Negro.

Does the primitive woman really respond to labour as we are led to believe? Our experience in South Africa is almost confined to the urban Native, if by this we mean that we are not privileged to observe the woman under tribal conditions repairing alone to the Bush to give birth. There is available to the author no reliable experience—written, spoken, or traditional—which can form the foundation for deductions concerning the psychological aspect of labour in the primitive woman of any race whatever. The matter of gaining the approval of a Native chieftain sufficiently to be allowed scope to observe labour amongst the women of his tribe has been considered seriously, but the difficulties are almost insurmountable. Official permission cannot guarantee acceptance of a strange accoucheur, however unobtrusive, by parturients and their mentors.

In spite of this lack of an opportunity to study the primitive parturient, it is possible to state that in the urban Bantu parturient there is present a fortitude and an acceptance of the situation such as is very rarely seen in the European, and hardly ever seen in the latter when cases of dystocia alone are considered. Against this observation must be placed the conviction that in hospital the Native is much more apprehensive than the European woman, and that when anything is amiss the Negro is more affected emotionally, and indeed out of all proportion to what is experienced in the white woman. No doubt all women have more fear in the maternity hospital than out of it; but in the case of the Negro uterine inertia, for example, occurs in a manner which seems quite unnecessary when judged by an attendant accustomed only to European behaviour. An observation that must be universal is the absence of resolution in the parturient who knows that she has recourse to the accoucheur and his reputed skill. In most primigravidae there appears to be an instinct that a rigid self-denial is being practised if the doctor's aid is not invoked, and this aid is usually visualized as being an operative termination of her travail. In the primitive woman there is no false, and withal evil, premise of this kind. Her tradition dictates what she so simply accepts, that delivery depends entirely on her own efforts. No doubt she is ignorant

of the curse "in sorrow thou shalt bring forth children." But once she finds herself in hospital, primeval independence is swallowed up in complete surrender to the ones with the higher knowledge. And how pathetic is artificial aid to uterine power!

One's early experience with Bantu antenatal cases stultified such judgment as was based on an experience of white women with disproportion. As an example, the case of a girl aged 13 years may be taken. Examination showed the pelvis to be still very small, but without any appreciable distortion. The diagonal conjugate was easily measured and found to be well under $3\frac{1}{2}$ inches. The father of this girl was particularly displeased about her seduction, and his chagrin was aggravated by the advice that a Caesarean section would be necessary. He consented to the compromise that the girl be given a trial labour in the clinic and, if transfer to hospital then became necessary, consideration of this step would be acceptable. It soon became obvious that highly instructive trial labours carried out on the district would be presented to one, because of a strong prejudice against maternity hospitals. The test of labour of the patient of 13 ended in defeat for myself, for labour terminated in undramatic fashion. The infant was alive, weighed 7 lb., and had a biparietal diameter of 9 cm. and occipito-frontal 11.2 cm.

In other cases the patient would be in hospital and fail to respond to drug induction of labour at term. A week or more after even trial labour was judged to be no longer humane, such a case of contracted pelvis would go into labour and deliver spontaneously in 5 or 6 hours of observed labour.

This led to the view that the size of the non-pathological pelvis was hardly ever an absolute factor in deciding in favour of Caesarean section. Provided that contractions are powerful, almost any natural obstruction can be overcome by the Bantu woman. The more difficult problem now emerges of having to decide how far uterine contraction may be allowed to take its course, for too great action may successfully end labour but kill the foetus. And this last result may be observed in the Bantu.

Material and Methods.

Introductory Note.

In order to become better acquainted with the bony passages as a factor in labour, skeletal material was studied in the Anatomy Department. It was realized that dry female pelves could only be available in comparatively small numbers, and that thorough study would depend for material on the living subject. This demanded radiographic methods. Experiment, however, demonstrated how unreliable X-ray pelvimetry was, and it became necessary to find the best and most efficient method with a precise knowledge of the range of error involved.

For the present study there is available a practical knowledge of the pelvic capacity of each parturient and the details of her labour. It is thus possible to consider the accomplishment of each woman in giving birth to her child, in order to discover what capacity of the pelvis is compatible with spontaneous delivery.

In reducing this problem to precise values one is guided by a consideration first suggested by Nicholson.[7] It has been shown that in 500 Bantu newborn the mean area of a cross-section of the head with biparietal and suboccipito-bregmatic diameters as axes (i.e. the fully flexed head) was 68.64 sq. cm. It follows that all planes of a pelvis must have a sufficiently large area to accommodate this largest area of the well flexed head. For the deflexed head a corresponding area of a cross-section with biparietal and occipito-frontal diameters as

axes may be taken. The corresponding mean area in the latter case was 80.64 sq. cm. If it be remembered that during labour the bony pelvis is occupied by structures other than the foetal head, but that moulding makes it possible for the head to occupy most of the available area of any pelvic plane, the interesting question arises as to what is the maximum pelvic contraction that would still allow spontaneous expulsion.

On this point Nicholson[7] comes to the following conclusion: "It seems then likely that the line below which normal delivery becomes a doubtful proposition should be drawn somewhere about an area of 90 square centimetres." Ince and Young[8] the other writers who have taken the trouble to express their findings in numbers and thus with greater precision than has been the custom, admit that their series does not contain sufficient evidence to suggest a figure lower than 90 sq. cm. as the limit of the area of the pelvic brim through which normal delivery is likely: they had only 1 woman with a brim area between 84 and 90 sq. cm., and 3 between 90 and 95 sq. cm. They refer to the teaching that the lower limits of probable natural delivery are a conjugata vera of $3\frac{1}{4}$ inches in a flat pelvis and $3\frac{1}{2}$ inches in a generally contracted pelvis. These give approximate areas of 87 sq. cm. for the flat and 78 sq. cm. for the generally contracted pelvis.

If the area of a cross-section of the foetal head is about 70 sq. cm., it would seem impossible for such a head to negotiate pelvic planes that are not above 70 sq. cm. at least. It might be guessed that a pelvic plane of at least 80 sq. cm. would be a requisite for spontaneous delivery. And this corresponds with the traditional belief stated above that in certain cases a true conjugate of $3\frac{1}{4}$ or $3\frac{1}{2}$ inches might permit natural expulsion of the foetus.

The series of Nicholson[7] and Ince and Young[8] totalled about 850 cases, whereas the present Bantu series consists of only 100 primigravidae. A report on the Bantu is, however, justified because of the small pelves encountered. The 850 English women provided only 3 brim areas below 90 sq. cm. and none below 85 sq. cm. Nicholson[7] had 4 outlet areas below 80 sq. cm., but minimizes the significance of contraction of this rather mobile portion of the girdle. Ince and Young[8] fail to discuss their small outlets specifically, and record no outlet areas in their special cases (including Caesarean sections). In the 100 Bantu primigravidae there were 14 areas below 80 sq. cm., 2 of these pelves having only the outlet area below 80 sq. cm. With a view to investigating levels of contraction that offered insuperable obstruction, the original plan was to consider in retrospect labours that had occurred in women admitted to the gynaecological ward with vesico-vaginal fistula. Of 25 such cases considered here, 14 had pelvic levels below 80 sq. cm. in area. This series contributed little to the study of labour in contracted pelvis. Nevertheless, the present analysis is based on 28 cases with areas below 80 sq. cm., and on this foundation the series bears comparison with the invaluable studies of the workers mentioned above.

Material.

(*a*) Vesico-vaginal fistula (25 cases).

These patients presented themselves at the gynaecological clinic with fistulae following labour. As ward patients awaiting operation they were X-rayed, and at the same time their histories were checked. On a few occasions all available cases were subjected to X-ray pelvimetry, but there was no conscious selection. A hundred cases could without much difficulty be thus studied radiographically, but there is a great weakness inherent in this material. No skilled obstetrician could allow labour

to proceed sufficiently long to cause a fistula. Therefore, the details of these labours must be inadequate because of the absence of a trained observer. Further, even the duration of the second stage will be unknown, because no trained attendant would allow this stage to be unduly protracted.

(*b*) Primigravidae from an antenatal clinic (103 cases).

These women were 103 consecutive Bantu primigravidae from the University Antenatal Clinic at Alexandra Township. This township is situated on the outskirts of Johannesburg and has a population of about 80,000. The men and some women are occupied in the city or suburbs, but not on the gold mines; and there are numerous schools and churches in the township which are owned by the inhabitants. There is a well established polyclinic from which *inter alia* a district service is operated. Students are in residence here and attend the clinic, there are several doctors on the permanent staff, and the full-time personnel of the University Department of Obstetrics and Gynaecology conduct the antenatal clinics. Midwives consult the obstetricians concerning cases of abnormal labour, and these are transferred to the Bridgman Memorial Hospital (maternity) when necessary. No instrumental or other complicated deliveries are effected on the district.

The group of primigravidae provided the following material:

Normal labours in women over 19 years of age	45
Normal labours in women under 20 years of age	39
Labour ending in stillbirth not due to labour	3
No record of labour	4
Cases transferred to hospital	12
Total	103

The age incidence of the normal labour group under 20 years of age was:

4 patients were aged 15 years
9 ,, ,, ,, 16 ,,
6 ,, ,, ,, 17 ,,
13 ,, ,, ,, 18 ,,
7 ,, ,, ,, 19 ,,

(*c*) Other Bantu material referred to is embodied in a D.Sc. thesis presented to the University of the Witwatersrand and entitled "A Critical Analysis of the Bantu Pelvis with Special Reference to the Female."[11]

Methods.

(*a*) The X-ray method of pelvimetry used was described in this journal (Heyns[9]). A further evaluation of the accuracy of the X-ray measurements is presented in Appendix I.

The calculation of areas of brim, cavity, and outlet was checked experimentally in the paper referred to.[9] The suggestion of considering brim and outlet shapes as ellipses and thence calculating their area came originally from Nicholson.[7]

The measurements sought from radiography were those laid down by Heyns,[9] and comprise areas of brim and outlet, pelvic brim index, height of symphysis pubis, depth of pelvic basin (lateral and anterior), and size of the pubic arch. These were obtained from two X-ray views, an antero-posterior with pelvic brim horizontal, and the Chassard and Lapine[10] method for the pubic arch. For the antero-posterior view the Potter-Bucky diaphragm was used; for the pubic arch the patient sat leaning well forward on a Lysholm grid.

Radiography was carried out at the Non-European Hospital which is adjacent to the Medical School and where the fistula cases are admitted. All the X-rays were done by the chief radiographer and myself.

(*b*) One feature of the pubic arch which was considered needs explanation. If the perpendicular distance from the antero-

superior edge of the symphysis pubis to the line representing the intertuberal diameter is great (the mean for 87 cases was 10.25 cm.[1]) and the distance between the ischial tuberosities small (mean 11.47 cm.[1]), it means that the foetal head has to traverse a greater depth of the pelvis before birth by extension becomes possible. Thus, if an arch is narrow, the uterine power required to drive the head beyond the level of the ischial tuberosities will be proportional to the depth of the anterior part of the pelvis.

This variable might be expressed as an index which, for descriptive purposes, will here be called the *pubic arch index*, and is expressed by $\frac{\text{D.P.B.,}}{\text{T.O.}}$ where D.P.B. represents the perpendicular distance on the film from top of symphysis to line T.O. which itself is the intertuberal diameter. In 76 cases of spontaneous delivery the index was less than unity in 85.5 per cent of this group. When the index approaches or surpasses unity, the pubic arch becomes unfavourable to labour.

(*c*) For the sake of analysis, area was the dimension on which chief reliance was placed in assessing

1. the capacity of a pelvis, and
2. the prognosis of labour.

The labour was then reviewed in the light of this value and the fact that the well-flexed Bantu foetal head presents a cross-section of 68.64 sq. cm.

An arbitrary level of 80 sq. cm. for the smallest pelvic plane below which insuperable obstruction may be expected was put to the test. The test was applied to the series of 103 primigravidae that provided 14 such small areas, and to 25 cases of vesico-vaginal fistula in whom labour was obviously associated with severe trauma. Concerning the second group, it was known how small the pelves were from experience in fistula operations, and that such trauma occurred in neglected cases that did not realise the value of modern obstetrical aid. In many of these cases labour terminates miraculously, and it was thought that a certain limit of pelvic contraction might be established in those women who sustain bladder fistulae.

The pubic arch index was analysed for record purposes. It is probably of greater value in moderate forms of obstruction and dystocia: in this paper severe degrees of obstruction are considered, and the accompanying dystocia, if any, evaluated.

Results.

A. *Vesico-vaginal Fistula Patients.*

Group I.

Smallest area 90 sq. cm. and over; 4 patients. Pubic arches were not X-rayed in any of the 4 cases. All radiographed in November 1943.

Evelyn (20 years); 92.5 sq. cm.; 1 child in 1940; normal labour.

Eileen (26 years); 92.4 sq. cm.; 1 child, born dead; in labour 4 days; no medical help.

Mary; 91.5 sq. cm. No reliable obstetric history obtained.

Anna (20 years); 91.1 sq. cm.; 1 child, alive; in labour 2 days; no doctor; anthropoid brim.

Group II.

Smallest area 80–90 sq. cm.; 7 patients.

Ida (30 years); 84.1 sq. cm. Pubic arch index under 1. Perfect arch. Para 3; 3rd labour in 1943. Instrumental delivery in a Natal hospital without obvious good reason for the bladder fistula which occurred for the first time after the 3rd labour.

Lephina (19 years); 82.3 sq. cm. Pubic arch index under 1. Perfect arch. Para 2. Last labour in March 1943 when fistula followed a forceps delivery. In labour 5 days and in a Natal hospital for all 5 days.

Nettie (24 years); 87.4 sq. cm. Good pubic arch, perfectly female, index less than 1. Delivered in hospital locally one month ago, August 1944. A primigravida, she was in labour about 30 hours. Difficult high forceps resulted in the stillbirth of a big foetus. Incontinence of urine 11 days after delivery.

Mary M. (27 years); 81.6 sq. cm. Narrow pubic arch with perfectly straight rami (index less than 1). Baby born in a country hos-

pital in August 1943, one year ago. Delivered by a doctor. Incontinence of urine and faeces followed. Labour started at home, and lasted 7 days in all. The baby was " manually removed."

Maria M. (32 years); 80.7 sq. cm. Very long pubic arch; moderate width; rather straight rami; index less than 1. Stillbirth 7 months previously. Labour lasted 7 days. Instruments were not used. During puerperium patient was not well.

Elizabeth Z. (26 years); 85 sq. cm. Long, narrow, pubic arch, rounded, index more than 1. " Seven months " premature labour, Incontinence followed: bladder always empty.

Dora; 87.1 sq. cm. Arch not X-rayed. Reliable obstetric history not obtained.

Group III.

Smallest area 70–80 sq. cm.; 12 patients.

Elizabeth T. (17 years); 76.0 sq. cm. Narrow pubic arch; long, rather straight rami; index over 1. Para 3; last child born 3 weeks ago. Pregnancy, labour and puerperium had all been normal. The patient spoke of a difficult delivery at home, resulting in stillbirth and urinary incontinence. Labour had lasted 1 day but the baby was born without assistance. The 2 other children were stillborn, the first being a very difficult labour.

Harriet (43 years); 79.5 sq. cm. Narrow, straight, extremely long arch with index 1.25. One baby 10 years ago. Born dead.

Katrina (24 years); 79.8 sq. cm.; moderate arch, rounded, index over 1. One labour only—stillbirth. Labour lasted 4 days; no doctor.

Flora (17 years); 77.6 sq. cm. Moderate arch, rounded, index over 1. Symphyseal height 4.3 cm. Para 1. Started leaking urine 13 months ago (February 1943) just after labour. Labour lasted 3 days—stillbirth.

Moetse (31 years); 75.4 sq. cm. Narrow arch, well rounded, index 1. Para 1. Labour 9 months ago (July 1943), lasted 3 days. A doctor delivered the baby after 3 days of labour.

Eva (19 years); 74.3 sq. cm. Narrow, very long arch, straight rami, index 1. Symphyseal height 4 cm. Para 1. No reliable history except that the baby was born dead.

Lena (30 years); 75.2 sq. cm. Long, narrow arch with straight rami; index under 1. Para 3, 2 dead. 2 labours lasted 3 days. Incontinence of urine after 2nd labour.

Selina M. (21 years); 79.0 sq. cm. Wide arch with rather straight rami; index under 1. One pregnancy 2 years ago (1942). Labour lasted 5 days when she was delivered of a large child. No doctor was present, but her mother " pulled the baby out."

Phyllis (19 years); 72.6 sq. cm. No X-ray of arch. Para 1. In labour 4 days, then sent to hospital locally. A senior obstetrician is said to have seen her. The baby was born alive but died after one week.

Julia N. (34 years); 78.5 sq. cm. No X-ray of arch. One child 14 years ago (1929). The patient declares that there was no difficulty, but labour lasted 3 days with strong pains. The baby is said to have been big.

Sarah (28 years); 79.4 sq. cm. No X-ray of arch. Obstetric history not available. Anthropoid brim.

NOTE that in the last 2 cases with almost equal areas of the cavity plane the conjugata vera in Sarah was 10.5 cm. or over 4 inches, but in Julia 8.9 cm. or 3½ inches. The respective brim indices were 109.3 and 79.5. The inadvisability of basing pelvic contraction on the true conjugate diameter is illustrated here, but became obvious to all when Caldwell *et al.*[11] called attention to the existence of their anthropoid type pelvis.

Miriam (18 years); 79.5 sq. cm. No X-ray of arch. Para 1. Labour lasted 6 days. Baby born dead in a hospital locally. Anthropoid brim (true conjugate 10.3 cm.).

Group IV.

Smallest area 60–70 sq. cm.; 2 patients.

Sophia (20 years); 69.8 sq. cm. Perfect female pubic arch, index less than unity. Para 1. Baby born one month ago (March 1944). In labour for 3 days, then called a doctor who delivered her with instruments. There may have been a craniotomy.

Area of cavity plane	= 69.8 sq. cm.
Area of brim	= 74.5 sq. cm.
Area of outlet	= 77.9 sq. cm.

Maria (18 years); Cavity 63.8 sq. cm.; brim 69.9 sq. cm. No X-ray of arch. Obstetric history not available.

Discussion of Fistula Patients.

Group I.

Of the 4 cases with areas all over 90, there

was only 1 stillbirth. None of these cases had medical help. No pubic arches were X-rayed. All were primiparae in the twenties. Nothing can be learned from these cases. As the pelves had sufficient capacity for spontaneous labour, malpresentation or malposition or trauma inflicted by the Native attendant must have caused the fistula.

Group II.

Seven patients—6 pubic arches available (Areas 80–90 sq. cm.).

Pubic arches. One arch had the index more than 1, 5 arches had the index less than 1.

This proportion of arch indices is similar to that for the 100 unselected Bantu primigravidae; 3 arches were perfectly female; 1 arch was narrow with perfectly straight rami; 1 arch was very long with rather straight rami, but was of moderate width.

The arch with index greater than unity was long and narrow, but rounded.

(*a*) The 3 cases with perfect arches had areas of the cavity plane 84.1, 82.3 and 87.4 sq. cm. respectively. In all 3 there is some evidence that a fistula should not have resulted; and even though labour may not have ended spontaneously, had forceps not been applied, there is no proof that bladder damage would have occurred.

All 3 cases were instrumental deliveries in a maternity hospital, two in Natal and one in Johannesburg. In the first case (Ida) there had been two previous labours, and there was no obviously good reason for the fistula which occurred for the first time after the third labour. The second case (Lephina) had had one child before without assistance. Fistula followed a forceps delivery after 5 days of labour, the patient actually having been in hospital for all of the 5 days. The third case (Nettie) was a primigravida delivered of a big stillborn foetus after 30 hours of labour. A difficult high forceps extraction was done, and the patient became incontinent of urine 11 days after delivery. While it is admitted that there was dystocia in these cases, the cause must be sought with the powers or the foetus, not the passages; and the resultant trauma was caused by instruments in two at least of the cases, and possibly by a prolonged second stage in the 5-day labour.

(*b*) In the next 2 cases aged 27 and 32 years, the cavity area was 81.6 sq. cm. in the first, and the outlet area 80.7 sq. cm. in the second. Both labours lasted 7 days. Both patients were delivered in hospital, but state that the baby was taken away without instruments.

(*c*) The case with the unfavourable pubic arch (Elizabeth Z.) had a cavity plane area of 85 sq. cm., and a "seven months" premature labour. Incontinence of urine followed due to a vesico-vaginal fistula. It seems probable that the fistula was due to trauma inflicted by some Native attendant. It is not uncommon in some districts to find perineal and vaginal trauma caused by various sharp objects. In Dora, the case with cavity area 87.1 sq. cm., there was no reliable obstetrical history, and the pubic arch was not X-rayed. In the early cases studied, pictures of the brim only were taken.

Of the 7 cases in Group II only the 2 described under (*b*) throw light on the question of the capacity of pelves which are dangerously small. In 7 days these women were unable to deliver themselves, instruments were not used during delivery, and the areas were the smallest of the group. The areas were as follows:

	(1) Sq. cm:	(2) Sq. cm.
Cavity	81.6	105.0
Inlet	86.6	111.2
Outlet	89.4	80.7

The first pelvis is small in all three planes, the second shows contraction of the outlet plane only. It seems, therefore, that an

area in the region of 80 sq. cm. is dangerously small, and, if there is some deflexion or a posterior position of the vertex, then spontaneous delivery is improbable.

Group III.

Twelve patients; 8 pubic arches available (70–80 sq. cm).

Pubic arches. Only 2 indices are less than unity; 4 indices are greater than unity and 2 indices are exactly 1.

In these smaller pelves of Group III, therefore, the anterior height of the pelvis minor tends to be greater than the outlet width (intertuberal diameter). In the 8 cases the depth of the pelvic basin measured laterally is on the average 8.88 cm., which is very close to the corresponding figure (8.77 cm.) found: (1) for 67 Bantu dry female pelves, and (2) for 87 radiographs of Bantu primigravidae.[1] Three of these eight pelves had this measurement over 9 cm., viz. 9.3, 9.6 and 9.7 cm.

The intertuberal diameter, however, was diminished and ranged from 8.7 to 10.8 cm., with a mean of 9.8 cm. This figure must be compared with a mean of 10.2 cm. for 67 dry pelves and 11.47 cm. for 87 radiographs of Bantu primigravidae.[1]

The pubic arches may be analysed thus:

	Index
Narrow, long, with straight rami	4 (++−o)
Narrow, well rounded	1 (o)
Moderate width, rounded	2 (++)
Wide arch, with rather straight rami	1 (−)

(*a*) In the first 4 cases the pubic arch index was greater than unity—2 arches being long and narrow with straight rami, and 2 of moderate width and rounded. Three patients were primiparous and one (E.T.) was a 3-para. All 4 women had had stillbirths, E.T. having lost all her infants at birth. None had had medical aid, so that all deliveries were spontaneous, though the duration was 3 days in one and 4 days in another. E.T., with a very unfavourable pelvis, considered that her labours had been normal, but declared that the first had been very difficult! Two striking features of this case are the resignation with which this girl had repeated stillbirths due to dystocia, and the observation that it was possible for 2 foetuses to negotiate her small pelvis without gross trauma to the bladder.

(*b*) The next 2 arches, with index 1, were both narrow, one being well rounded and the other long with straight rami. Both were primiparae, Moetse having been delivered by a doctor and having an intertuberal diameter of 8.7 cm. Eva was known to have had a stillbirth, but Moetse's history was equivocal. It is a matter of honour with these women to be able to claim offspring, and experience has shown that in some cases the claims have to be accepted with reserve.

(*c*) There follow 2 arches with the favourable quality of possessing indices less than unity. In one case, however, the arch was wide with rather straight rami; and the other possessed the converse characters narrow, long, with straight rami. The patients were a para-3 and a para-1. The former with a cavity plane area of only 75.2 sq. cm. had had one live child, 2 labours lasting 3 days, with urinary incontinence after the second labour. She had, therefore, conceived on the third occasion, in spite of the fistula. The other patient's labour had lasted 5 days. Instrumental delivery was not performed in these cases. From both patients (of whom the second had the wide and in most respects normal female pubic arch) one learns that labour becomes extremely difficult when the smallest pelvic plane has an area below 80 sq. cm. While great uterine power may drive the foetus through such a pelvis, it is observed that these parturients have a great struggle.

(*d*) In 4 patients the arches had not been studied radiographically. Three were para 1, there being no labour notes for the

fourth. Labours lasted 3, 4 and 6 days. Two of the deliveries occurred in hospital: one was a stillbirth, and in the other an area of 72.6 sq. cm. allowed passage of a live child that survived for a week. The last 2 patients of Group III had cavity plane areas of 79.4 and 79.5 sq. cm.; and both had anthropoid type pelves.

Group IV.

Two patients. One pubic arch available (60–70 sq. cm.).

It is to be noted that the pubic arch in this very small pelvis was perfect in every respect. In these two cases one delivery was instrumental, possibly a craniotomy; the other is not recorded.

Comment.

When these cases are operated upon *per vaginam*, access is the main difficulty. In the majority of cases no cervix can be identified, there is a considerable amount of scar tissue in the vagina which itself often shows extensive loss of tissue, and the upper part of the pubic arch is so narrow as to make the fistula appear inaccessible when first explored. Clinical assessment of the capacity of the pelvis by digital exploration in an average case gives the impression of extreme contraction; and one wonders first how these women conceive when they are so poorly equipped for parturition, and secondly how they contrive to deliver themselves. In the neglected cases that end in spontaneous expulsion of the foetus after several days of strong labour, one feels almost that the foetus must have sloughed away in a macerated condition. Occasionally a parturient sends for help after the end of the second stage, and the infant's head is moulded and compressed beyond recognition. The baby is either born dead or dies in an hour or so.

The 25 cases dealt with above do not contribute anything to precise knowledge concerning the level below which the capacity of the pelvis becomes inadequate for spontaneous delivery. Several of these women delivered themselves without aid, but with resultant fistulae.

It will be seen that a foetus can be expelled through equally small pelves without severe recognizable trauma.

TABLE I.

Areas of Small Pelves.

Pelvic plane areas in patients with vesicovaginal fistula. The smallest area is shown, and this is the cavity plane area in all cases except the two marked (o).

60–70	70–80	80–90	Over 90
sq. cm.	sq. cm.	sq. cm.	sq. cm.
63.8	72.6	80.7 (o)	91.1
69.8	74.3	81.6	91.5
	75.2	82.3	92.4
	75.4	84.1	92.5
	76.0	85.0	
	77.6 (o)	87.1	
	78.5	87.4	
	79.0		
	79.4		
	79.5		
	79.5		
	79.8		

Primigravidae with pelvic plane areas below 80 sq. cm.

Brim area sq. cm.	Cavity plane area sq. cm.	Outlet area sq. cm.
66.6	60.0	
75.4	71.7	64.5
69.4	64.7	
74.6	68.6	78.5
76.0	72.0	
104.9	100.0	72.6
81.4	76.1	96.7
81.5	77.0	76.0
91.0	86.5	77.0
83.5	77.8	95.9
83.2	78.0	99.3
85.3	78.8	
83.1	79.4	94.1
84.1	79.4	

100 PRIMIGRAVIDAE.

The group of primigravidae provided the following material.

Normal labour in women over 19 years of age	45
Normal labour in women under 20 years of age	39
Labours ending in stillbirth not due to labour	3
No record of labour	4
Cases transferred to hospital	12
	103

The age incidence of the normal labour group under 20 years of age was:

4 patients were aged 15 years
9 ,, ,, ,, 16 ,,
6 ,, ,, ,, 17 ,,
13 ,, ,, ,, 18 ,,
7 ,, ,, ,, 19 ,,

Analysis of the distribution of different values of the pubic arch index was as follows:

(*a*) Normal labours in the under 20 age group:
Index not less than 1 4
Index less than 1 28 (2 areas under 80)
(*b*) Normal labours in the over 19 age group:
Index not less than 1 6 (1 area under 80)
Index less than 1 31 (3 areas under 80)
(*c*) Miscellaneous (macerated foetus, lost cards, et cetera)
Index not less than 1 1 (area under 80)
Index less than 1 6
(*d*) Hospital cases.
Index not less than 1 4 (2 areas under 80)
Index less than 1 7 (1 area under 80)

The cases delivered at home, therefore, had 11 or 14.5 per cent of pubic arch indices not less than unity. The cases transferred to hospital showed a corresponding figure of 36.4 per cent. This difference is 1.46 times its standard error, and is not significant.

It is not sound to take hospital or assisted deliveries as a standard for analysing unfavourable features such as "long arch," because a spontaneous labour may have been even more difficult than the former labours.

An analysis on the assumption that 80 sq. cm. was the critical value for the pelvic capacity was based on the smallest area of any pelvic plane. At the outset, therefore, interest was confined to areas below 80 sq. cm.

Age in years		
15	No area under 80	
		Labours all normal
16	3 areas under 80	
17	No area under 80	
18	3 areas under 80	
19	No area under 80	
over 19	8 areas under 80	
		Labours all spontaneous
Total	14 areas under 80	

Of the 14 cases, 12 reached term normally and 2 were as follows: (i) Macerated foetus born at full term. R.O.A. Male; (ii) It emerged later that this patient was not pregnant. It is probable that abortion had occurred in early pregnancy.

The most immediate possibility in analysing the primigravidae is to consider: (1) the above 14 examples with area below 80 sq. cm., and (2) the patients transferred to hospital.

The latter group numbered 12, and of these only 3 pelves had minimum areas below 80 sq. cm. It must be emphasized that operative delivery was effected only in hospital. Therefore, 11 low area pelves were associated with spontaneous delivery, while the operative deliveries were 3 Caesarean sections and 2 forceps extractions.

Cases Transferred to Hospital.

I. Seven cases delivered themselves without assistance, and were sent to hospital for

various reasons. Their records are as follows.

A primigravida of 39 years was transferred on account of her age, i.e. as a precautionary measure. She had a capacious pelvis except for the outlet area which was 87.5 sq. cm. Labour was uneventful.

Three patients with adequate pelves were sent in during labour, but delivered spontaneously.

One patient aged 16, with brim and cavity areas respectively 84.6 and 81 sq. cm., brim index 95, and with angular pubic arch was sent to hospital on account of a blood pressure of 160/120. She was delivered normally on the next day after a second stage lasting 35 minutes, the first stage having been $15\frac{3}{4}$ hours. The infant weighed 7 lb. 5 ozs. The vertex position was diagnosed during labour as L.O.P.

There was one case of uterine inertia. The first stage lasted $63\frac{1}{2}$ hours, the second 70 minutes. The position of the vertex was diagnosed as L.O.P. An infant weighing 7 lb. 7 ozs. was born with an excessively long caput succedaneum, but on discharge was alive and well. The brim area was 92.5 sq. cm., outlet area 80.8 sq. cm., brim index 93.5, and pubo-sacral diameter 10.4 sq. cm.

One spontaneous delivery in hospital ended in a stillbirth, the foetal weight being not recorded. Labour lasted $17\frac{1}{2}$ hours, the second stage $1\frac{1}{2}$ hours. The cavity plane had the smallest area, 82.3 sq. cm., and the brim index was only 88.2.

Of these 7 cases, the first 4 mentioned are of no interest, their admission to hospital resting on causes not relevant to the present inquiry. The last 3 labours, though they terminated spontaneously, exhibit pelvic levels much lower than any found in some 850 English women of the series analysed by Ince and Young[8] and Nicholson.[7] No area was below 80 sq. cm. in these 3 Negroes. The labour notes give an impression of what is accomplished by these primigravid parturients.

II. In this group, significantly different from Group I in that operative measures were here employed during delivery, there are 5 cases. There were 3 Caesarean sections and 2 forceps deliveries. In 3 women areas reached the low level of under 80 sq. cm., the other 2 being a patient who had been subjected to Caesarean section previously, and a forceps extraction. In order to understand more of these women in labour, some details will be recorded concerning all 5 cases.

(i) The indication for the previous Caesarean section was not known, and in the absence of delivery by the natural passages this patient was included in the series of primigravidae. The second section was performed only because of the first, the pelvis not being contracted except at the outlet. Brim area was 95.5 sq. cm., outlet area 83.7 sq. cm., brim index 95.5; intertuberal diameter 10 cm., pubo-sacral diameter 11.5 cm. The operation resulted in mother and infant both being in good condition.

(ii) A girl of 16 years with the following pelvic measurements. Areas (sq. cm.): Cavity 86.5, brim 91, outlet 77. Brim index 89.3. Intertuberal diameter 9.6 cm., pubo-sacral diameter 10.3 cm.

Clinically it was thought that this pelvis had a funnel tendency, and the radiographic confirmation of this diagnosis led to the decision to perform an elective Caesarean section. It will be agreed that trial labour with a severe degree of outlet contraction is inadvisable, for the stage of low mid-forceps extraction is easily reached—but safe retreat after "failed forceps" in such a case is denied. As frequently happens—and it is this factor which affords an opportunity of observing what would otherwise be an inhuman and dangerous experiment

—permission for an elective operation was refused.

The patient was, therefore, given 2 ounces of castor oil on September 22nd, 1944. Labour commenced the same day. Pains were slow at first, then increased, and at 11.30 p.m. occurred regularly. Only a small part of the head had engaged in the brim, and flexion was poor. An hour later (12.30 a.m.) the patient was sent to hospital. Caesarean section was done a few hours later, a living child being obtained. A small ovarian cyst was found at laparotomy.

(iii) This patient showed an extreme degree of pelvic contraction and in addition an obvious lumbodorsal kyphosis. Areas (sq. cm.): Cavity 60, brim 66.6. Brim index 88.2 (conjugate 8.2 cm. and transverse 9.3 cm.). The pubic arch index was 1.14 indicating a very long arch, and the angle was very narrow.

Intertuberal diameter 8.5 cm., interischio-spinal diameter 8.6 cm. Pubo-sacral diameter not available. Caesarean section was performed.

(iv) High forceps delivery in a primigravida aged 25 years. Areas (sq. cm.): Cavity 78, brim 83.2, outlet 99.3. Brim index 81.8 (conjugate 9 cm., transverse 11 cm.). The fore-pelvis at the brim was narrow, almost angular. The pubic arch index was greater than 1, but the arch was well rounded. Intertuberal diameter 9.2 cm., pubo-sacral diameter 12.8 cm., interischio-spinal diameter 9.9 cm.

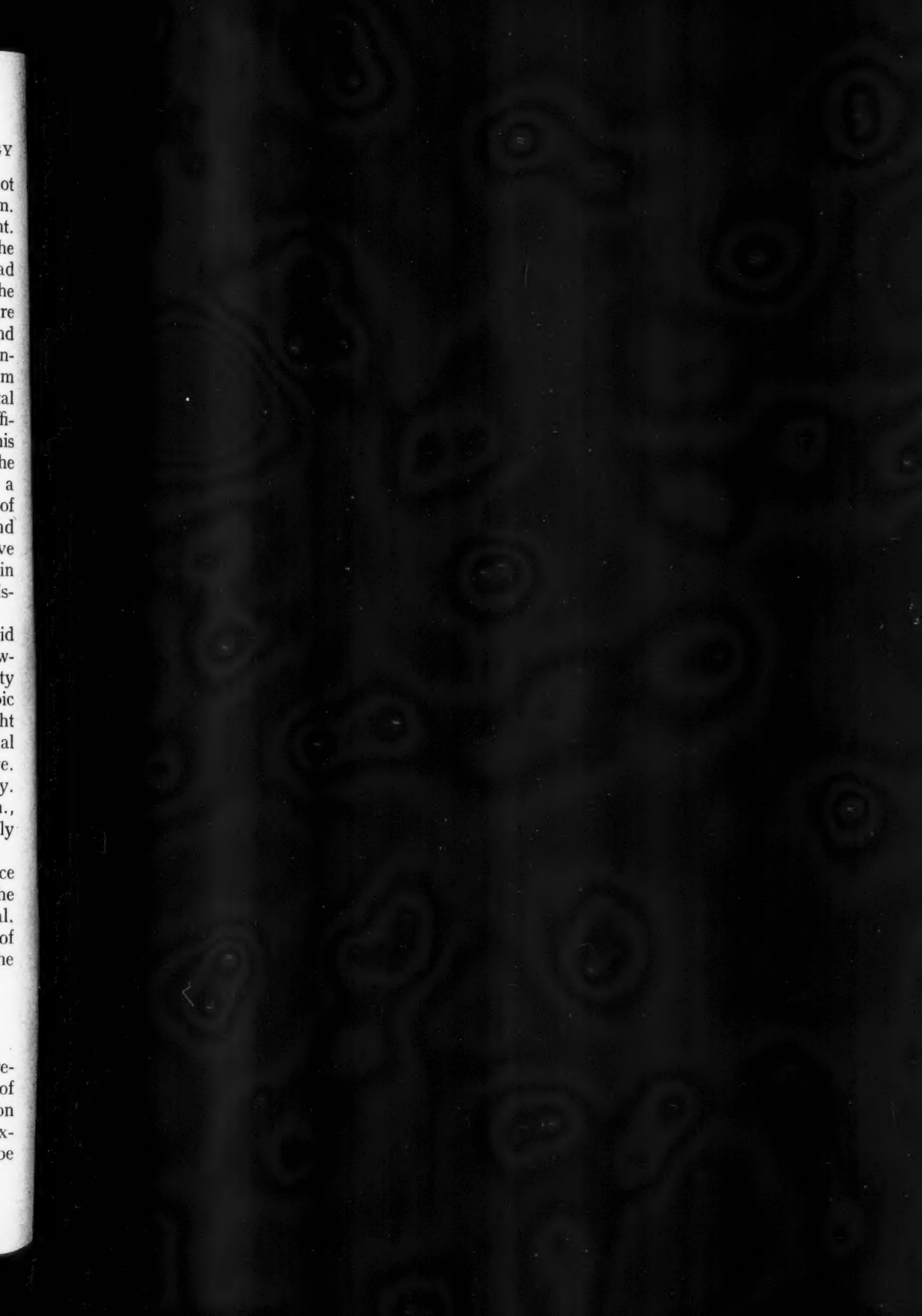
The patient went into labour on a Sunday. A member of the University staff reported to me that a large amount of meconium was being passed, but that the foetal heart was very satisfactory. The advice was that the case should merely be watched. The patient was sent to hospital at 10 a.m. next day. Unfortunately, the occipito-posterior position of the vertex which was present was not identified, and thus immediate Caesarean section was not done. Furthermore, it was not until 5 p.m. that one of our junior staff saw the patient. The os was not fully dilated and the greatest circumference of the foetal head had not negotiated the pelvic brim. The patient's pulse was 150 and temperature 102 degrees. Section could not be done and it was decided to wait. On Tuesday morning the staff member was called to perform craniotomy, but he thought that the foetal heart was still present. An extremely difficult high forceps delivery followed and this triumph was crowned by the fact that the baby was alive; but the infant was in a precarious state with violent moulding of the head. The mother recovered soon and left hospital in average time with a live child. This unhappy case is unique in several respects, but the attendant displayed a skill which matched the event.

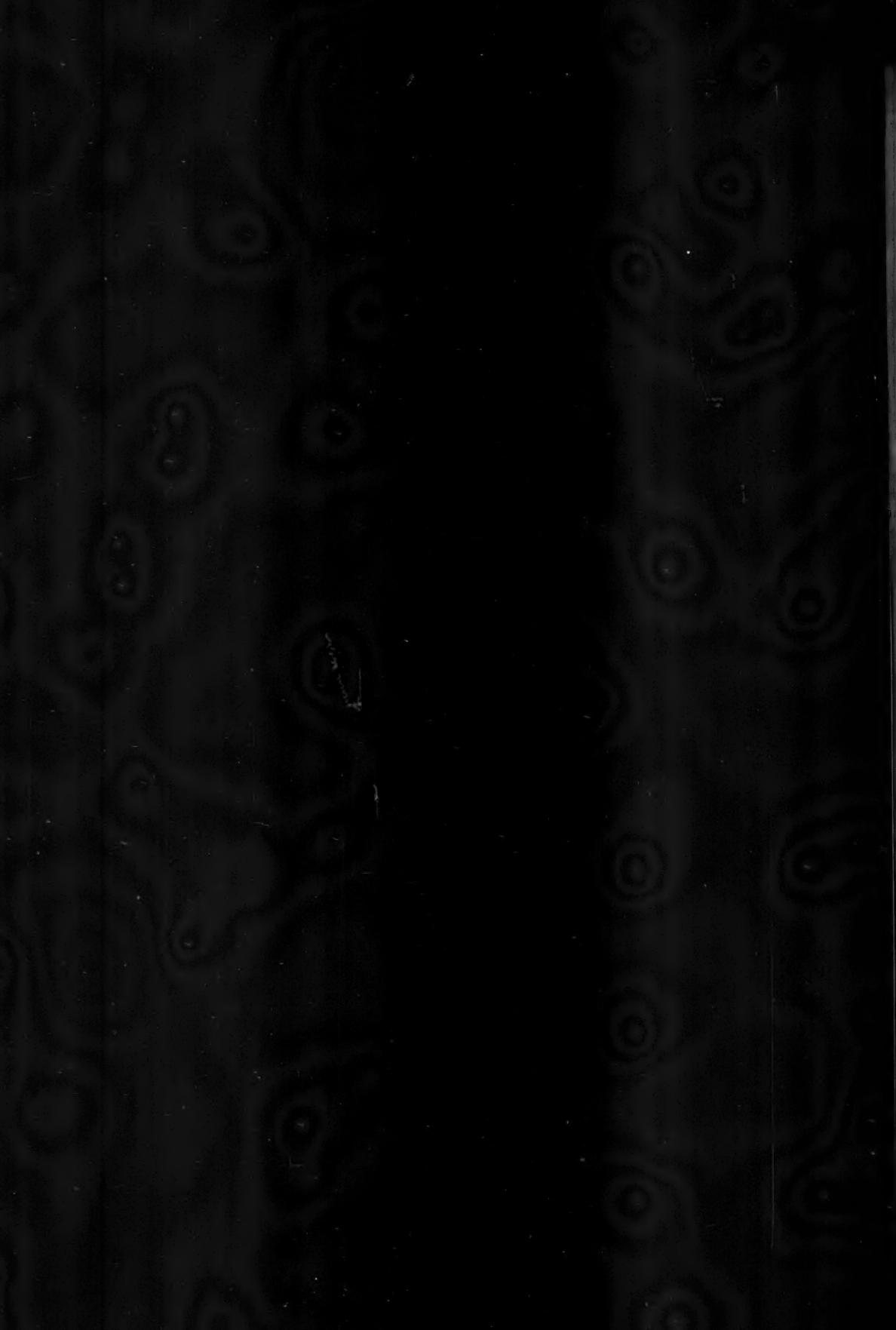
(v) A patient aged 19 had an anthropoid type pelvis (brim index 105.8) of the following dimensions. Areas (sq. cm.): Cavity 90, brim 94.1, outlet 87.5. The pubic arch index was over 1, the vertical height of the pubic symphysis above the ischial tuberosities being 10.7 cm., a high figure. This indicates a long pelvis anteriorly. Outlet diameters—intertuberal 10.5 cm., interspinal 9.4 cm. The arch was fairly well rounded.

It was observed on district that advance of the head had become arrested, and the patient was persuaded to go to hospital. Forceps delivery resulted in a stillbirth, of which the weight was not recorded. The reason for this outcome is not clear.

A Case that Failed to go to Hospital.

In contrast to the above cases a most remarkable labour occurred in a woman of 27 years who had had a Caesarean section for the first pregnancy. It had been explained that another section would be





absolutely necessary, for the pelvis had been found to have the following dimensions. Areas (sq. cm.): Cavity 71.7, brim 75.4, outlet 64.5. Brim-index 98.9 (conjugate 9.5 cm., transverse 9.6 cm.).

The pubic arch index was less than 1, the anterior depth of the pelvic basin being 9.5 cm., and the lateral depth 8.8 cm. The arch was well rounded. Intertuberal diameter 10.1 cm., inter-spinal diameter 10.4 cm., pubo-sacral diameter 9.1 cm.

The patient sent for help after the baby had been born. There was extensive perineal laceration. The baby was a female weighing 6½ pounds, and the head was moulded into a misshapen mass. The infant died an hour after birth.

The remarkable feature of this case was not the fact that the uterus with an old scar could withstand such an assault, but that it was at all possible for unaided uterine power to drive a foetus through such a small pelvis. The patient had been in labour for about half the night, and accomplished her feat in the absence of a nurse. So excessive was the force required that the baby succumbed, and the character of the labour was readily appreciated by nursing attendants from the extreme moulding of the head.

Cases with Pelves Possessing a Plane with Area Below the Critical Level of 80 sq. cm.

There were 14 cases out of 103 consecutive, unselected primigravidae that had some level of the pelvis with an area below 80 sq. cm. As 3 radiographs of the brim were of too poor quality to measure, it can be said that 14 per cent of this series presented pelves contracted below the arbitrary critical level of 80 sq. cm. This group is more important than the hospital group, of which it includes 3 cases, because operative delivery may be indicated in malpresentation or malposition, and a case may be transferred to hospital for reasons other than dystocia due to faults in the passages. What is being studied here is first the capacity of the Bantu pelvis and second, and more important, the achievement of the woman in overcoming whatever resistance proves to be present. An impression of the efficiency of the powers will be gained from these two factors. Faults in the passengers are irrelevant to the present investigation, except that indirect features such as abnormal birth-weight may call for comment.

No girls aged 15, 17 and 19 years had pelves of the size now under consideration.

Girls aged 16 years. Three cases.

1. Caesarean section. Described as Case ii under II of the hospital cases.

2. A school girl who was disgruntled at becoming pregnant. This patient, seen 2 years ago for radiography, has made frequent appearances in my ward and seems to be a schizophrenic. Areas (sq. cm.): Cavity 100, brim 104.9, outlet 72.6. Inter-ischio-spinal diameter 8.4 cm., pubo-sacral 11 cm.

Antenatal attention was given by me personally until very near term. The patient then disappeared for several months, and on her return pretended that she had never been pregnant. She had no doubt destroyed the baby, but appeared to be none the worse for any of her experiences. A year later I recognised the patient in my ward, this time under an assumed name. When I mentioned her full Native name, she confessed. It must be presumed that labour had been unassisted.

3. Areas (sq. cm.): Cavity 68.6, brim 74.6, outlet 78.5. Pubic arch—index less than 1, interspinal diameter 11.1 cm., intertuberal 12.6 cm.; pubo-sacral 10.4 cm. The arch is wide and very well rounded. Brim-index 92.8 (conjugate 9 cm., transverse 9.7 cm.). A normal labour ended in the stillbirth of a female weighing 7½ pounds.

Girls aged 18 years. Three cases.

4. Areas (sq. cm): Cavity 64.7, brim 69.4. Pubic arch—index less than 1, interspinal diameter 8.5 cm., intertuberal 10.5 cm., pubo-sacral diameter not measured. Arch rounded. Brim-index 98.1 (conjugate 9.0 cm., transverse 9.2 cm.). The baby, weighing 6 pounds, was born before arrival of the nurse.

5. Areas (sq. cm.): Cavity 79.4, brim 84.1. Pubic arch—index less than 1, interspinal diameter 11.2 cm., intertuberal 12.2 cm., pubo-sacral diameter not measured. Arch rounded. Brim-index 88.2 (conjugate 9.4 cm., transverse 10.7 cm.). A macerated foetus was born at full term. Male. R.O.A.

6. This patient came for X-ray as an early pregnancy. Vaginal haemorrhage started while she waited in the X-ray department. A note on my X-ray card refers to her having pronounced interstitial keratitis. The patient reported later at the antenatal clinic and an entry was made that she was not pregnant. It is possible that this patient aborted; but in spite of the absence of parturition, pelvic measurements are recorded for the sake of analysis.

Areas (sq. cm.): Cavity 72, brim 76. Pubic arch—index more than 1, interspinal diameter 10.9 cm., intertuberal 9.9 cm., no pubo-sacral diameter available. The arch is very narrow. Pronounced convergence of this pelvis—dangerous outlet. Brim-index 84.6 (conjugate 8.8 cm., transverse 10.4 cm.).

Women aged 20 years and more. Four cases.

7. This patient was described under II of the hospital cases as "a case that failed to go to hospital". Previous Caesarean section and, on this occasion, she delivered herself before the nurse was called. The foetus weighed $6\frac{1}{2}$ pounds and died an hour after birth.

8. The patient described as (iv) under II of the hospital cases. High forceps delivery. Live child.

9. Areas (sq. cm.): Cavity 77.8, brim 83.5, outlet 95.9. Pubic arch—index less than 1, interspinal diameter 10.8 cm., intertuberal 12.4 cm., pubo-sacral 11.3 cm. Arch rounded. Brim-index 93.2 (conjugate 9.6 cm., transverse 10.3 cm.). Normal delivery of a male weighing 7 pounds. The infant was asphyxiated but responded to treatment.

10. Areas (sq. cm.): Cavity 79.4, brim 83.1, outlet 94.1. Pubic arch—index less than 1, interspinal diameter 9.5 cm., intertuberal 11 cm., pubo-sacral 12.6. Arch very well rounded. Brim-index 107.3 (conjugate 10.4 cm., transverse 9.7 cm.).

It is to be noted that an anthropoid type pelvis in this case had an area of the upper planes as low as 80 sq. cm. It has been our experience with skeletal material that the anthropoid type only rarely possesses small dimensions.

A full-time female was born spontaneously, weighing 5 pounds 14 ounces. The patient had slight pains for 2 days, after which she was obviously in labour. The membranes ruptured early next morning, and the baby was born at 9.5 a.m.

Women of Unknown Age. Four cases.

It is not uncommon for a Bantu woman to be ignorant of her age.

11. This patient was described as (iii) under II of the hospital cases. Caesarean section. Area of cavity plane was only 60 sq. cm.

12. Areas (sq. cm): Cavity 76.1, brim 81.4, outlet 96.7. Pubic arch—index less than 1, interspinal diameter 10.7 cm., intertuberal 11.9 cm., pubo-sacral 11.5 cm. Arch rounded. Brim—index 85.6 (conjugate 9.1 cm., transverse 10.6 cm.). Probably the platypelloid type (Caldwell *et al*).

Normal delivery of a live baby weighing 6½ pounds.

13. Areas (sq. cm.): Cavity 77, brim 81.5, outlet 76.0. Pubic arch—not radiographed. Interspinal diameter 9.2 cm., pubo-sacral 10.5 cm. Digital palpation showed that the arch was wide. Brim—index 102.1 (conjugate 10.0 cm., transverse 9.8 cm.). The patient was delivered of a female weighing nearly 7 pounds. L.O.A. The baby was asphyxiated but survived.

14. Areas (sq. cm.): Cavity 78.8, brim 85.3. Pubic arch—index more than 1, interspinal diameter 10.0 cm., intertuberal 10.2 cm., no pubo-sacral diameter available. The arch tended to be angular. Brim—index 79.9 (conjugate 8.95 cm., transverse 11.22 cm.). Android type brim. Normal delivery of a live child weighing 7 pounds.

Notes on Spontaneous Labours Not Discussed Under the Hospital or Under 80 sq. cm. Group.

There were 34 patients aged 15 to 19 years, and 40 patients of 20 years and over. These cases were delivered on the district and had pelvic areas which were all over 80 sq. cm.

J.Z. (age 16). Zulu. Normal labour. Live child weighing 8½ pounds. Areas (sq. cm.): Cavity 91.3, brim 97.9, outlet 89.6. Pains started during the night. Help sent for at 5.55 a.m. Membranes ruptured during the night (time unknown). Male infant born at 10.45 a.m. Placenta and membranes expelled complete at 11.5 a.m. Blood loss normal. Uterus firmly contracted.

J.N. (aged 15). Zulu. Normal labour. Areas (sq. cm.): Cavity 80.5, brim 86.5, conjugata vera 9.6 cm, brim index 89.7. Labour lasted 20 hours; 2nd degree laceration; birth-weight not recorded.

Three patients had live babies weighing 10 pounds. Areas of cavity plane were respectively 116.8, 99.5, and 95.6 sq. cm. The outlets were all adequate. The patient with the smallest pelvis was one of our nurses (I.M.), the areas in sq. cm. being: cavity 95.6, brim 99.5, outlet 99.0.

Conclusions.

The two English series of parturients previously studied, those by Nicholson[7] and Ince and Young,[8] provide the only analyses known to us which aim at a precise evaluation of pelvic capacity as a factor in parturition. Whereas these investigators did invaluable work in presenting radiographic data in large numbers of gravid women, they had the misfortune to deal with material in which there was an absence of that degree of pelvic capacity which causes dystocia *per se*. It is recog-

	15–19 years		Over 19 years	
	No.	Per cent	No.	Per cent
Birth-weight 8–9 pounds	8	23.5	11	27.5
9–10 pounds	0		0	
10 pounds	0		3	7.5
Born before arrival of attendant { Total	11	32.4	8	20.0
Born before arrival of attendant { Pelvic area under 90 sq. cm.	3	8.8	3	7.5
Areas between 80 and 90 sq. cm.	13	38.2	11	27.5
Breech presentation*	1		0	
Stillbirths	0		0	

* This breech presentation was the only one in the total series. The baby weighed 4 pounds and was probably premature.

A few labours will be described to illustrate further what is experienced in these cases.

nized that these series derive from London and English rural populations. In the industrial English Midlands and Scotland small pelves and their effect on labour can no doubt be more profitably investigated, but in these areas the degree of rickets would complicate research into the effect of morphological types of pelvis on normal parturition. An opportunity of studying labour in the non-pathological small pelvis has been offered in the case of the South African Negro or Bantu. Rickets in this racial group, though not negligible, does not often lead to gross distortion of the pelvis. In this respect the Bantu pelvis is comparable with that existing in London and any other area in which the girdle has undergone uninterrupted development.

It has been shown, first of all, that the size of the new-born Bantu baby is in no respect different from that found in higher races. The mean birth-weight of nearly 7 pounds[9] is below the average for white races, but this is probably due to less subcutaneous fat and cannot exert great influence on the normality of parturition. These facts concerning the Bantu are fundamental.

It has been shown, secondly, that the necessity for operative assistance in the Bantu parturient is exceptional. Instrumental delivery including Caesarean section was called for in only 5 out of 103 cases; a spontaneous delivery was accomplished in 95 per cent of the primigravidae, in spite of the fact that 14 pelves had some plane less than 80 sq. cm. in area and 24 had a corresponding area between 80 and 90 sq. cm. In 850 of the English women mentioned there were only 3 pelves with brim areas below 90 sq. cm., all being above 85 sq. cm. No further argument is required to confirm the claim that the South African Negro parturient is superior functionally to her European counterpart. What is the reason for this ability in the Bantu to expel a foetus through a smaller bony canal than is usual in the European?

It must be admitted that there is no incalculable virtue inherent in the Bantu woman. Successful labour depends on three main factors: the passenger which, for purposes of the present inquiry, is of a constant nature; the bony passages which exhibit pronounced contraction more frequently in the Bantu; and the powers of expulsion. It is the quality of the powers that offers an explanation. There can be no doubt that fundamentally the white woman can accomplish as much as the Bantu. Concerning white women, however, it is generally admitted that faults in the powers are responsible for a great majority of all the complications met with in abnormal labour. It is submitted that in the European there is an unfavourable emotional background which has an inhibitory effect on efficient uterine action. Where in any individual parturient there is emotional stability supported by an unwavering resolution to push through with the task of spontaneous delivery, and where the realisation that obstetric aid is readily available is not over emphasized or too great dependence on such aid is absent, the achievement of the Bantu woman may always be equalled. The question of the magniture of uterine force that can safely be allowed is not relevant to the present argument, and indeed rarely enters into considerations of parturition in the white woman.

There is evidence in the cases quoted that the Bantu woman in many instances does not even entertain the idea that modern trained assistance is available. Thus a woman with a very small pelvis had three consecutive stillbirths without appealing for aid. This is a disadvantage, but her tradition must be compared with that of the European who considers that she has engaged an obstetrician who knows more

about parturition than she does, and whom she intends giving abundant opportunity of exercising his ability. At the risk of being accused of begging the question, it is to be pointed out that the Bantu experience further strengthens the concept that faults in the powers are responsible for most dystocias, for simple dystocia due to contracted bony passages can almost be eliminated by fostering the will in a parturient to deliver herself.

How does a normal-sized head with a cross-section of 70 sq. cm. succeed in passing across pelvic planes which have an area below 70 sq. cm? This is obviously due to moulding of the foetal head. If a spherical lump of plasticine of diameter 2 inches is to be forced through a ring of diameter 1 inch, the feat may be accomplished by rolling the lump of plasticine between the fingers and making it pass end-on through the ring. This is in effect what occurs in the case of the foetal head. The illustration is based on theoretical grounds, but it is now seen that with powerful contractions and extreme moulding, a flexed head with a certain cross-section area may negotiate a girdle of smaller area.

The South African Negro pelvis is smaller than that of the white woman, but the foetal head is, nevertheless, of comparable size. Perin[12] reports external measurements from 2,033 indigenes from Kimvula, Belgian Congo. The external conjugate average of 17.5 cm. suggests small pelves, and Perin believes that these natives are a degenerating race, no female exceeding a height of 1 metre 50 cm. However, the neonatal cephalic measurements show the head to be only slightly smaller than that of the Bantu, the biparietal and suboccipito-bregmatic diameters both being just under 9 cm. Similarly Pan's Hindu pelves[13] had a mean calculated brim area of 95.1 sq. cm. which is equal to the smallest area (95) of Ince and Young's range. The only measurement of the Hindu babies given is the mean birth-weight of 5 pounds $6\frac{1}{4}$ ounces in 100 observations. Leicester's[14] figures for Indian new born head measurements indicate that the Indian heads (e.g. Bengali) are considerably smaller than those of the Bantu. It seems as though inferiority of the female adult skeleton in the two African races (*vide* the pelvis) is not matched by smaller dimensions of the foetal skeleton. In the Hindu it is possible that the purdah woman produces a species of purdah child of which even the growth has been inhibited by fantastic environmental shortcomings during pregnancy.

The Africans, on the other hand, are relatively vigorous, independent, and quite undisciplined. It may be suggested that the smallness of the pelvis is due to malnutrition during the second and perhaps third year of life. This is possibly an epoch during ontogenetic development when the future adult pelvis is foreshadowed; and lack of calcium, phosphorus, and vitamins at this time may prejudice bone growth sufficiently to produce the smallish pelvis of the Bantu. The young child is unable to fend for itself and at this stage is completely dependent for nutrition on what is directly given to it. The conditions of life can be gauged from the fact that even in areas where the white man exercises his influence the infantile mortality is 500 per thousand and sometimes more. The mortality is approximately known for relatively small communities, and even here there is difficulty in arriving at the figures; but it is generally agreed that the mortality for the whole country must be about 500 per thousand.

The reason for good skeletal development in the Bantu foetus and in the foetal head of Perin's African race may be explained on the assumption that during pregnancy the mother, with her small pelvis now fully crystallized, looks after herself with aggres-

sive acquisitiveness and feeds on the best that is available. This advantage to the foetus, strengthened possibly by an inherent hardiness for the skeleton to grow in utero even under unfavourable conditions, produces a head which is as large as that found at birth in better favoured communities (e.g. European). Thus a normal-sized passenger has to negotiate obstructed passages. Where the disproportion is exaggerated the mother has still to depend on Nature for her delivery, and she believes that death in childbirth is the alternative to success.

Concerning the arresting data presented for Bantu parturition, a final point requires discussion. It may be felt that the contents of this paper are acceptable provided that the X-ray measurements are reliable. Experimental work has shown the value of the method used (Heyns[9]); and in addition the data of Appendix I confirm what was suggested tentatively at first. It may be accepted that the area of the plane of the cavity is, as it is shown on the X-ray film, the narrowest part of the girdle proper. There can be very little error about the area calculated in this case: the only mistake made by radiologists was to take this shadow to represent the outline of the brim. The brim can never be shown radiographically, whatever method is used. The outlet area is uncertain because the pubo-sacral diameter can never be measured accurately; but the outlet plane is not rigid, and its ability to increase in area detracts from the value of outlet areas. Most of the small areas shown in this paper have been the reliable "cavity" areas. The pubic arch measurements may be accepted as accurate.

The appendix also indicates that the method of measuring the conjugata vera gives a mean increase over the true conjugate of 0.3 cm. It is to be noted, therefore, that the small conjugates referred to for some pelves (i.e. below 9 cm.) are in fact even shorter than recorded.

Summary.

1. X-ray pelvimetry has been carried out on 103 primigravidae and 25 cases of postnatal vesico-vaginal fistula. Parturition has been assessed on the basis of the areas of the planes of the brim, cavity, and outlet of the pelvis.

2. The fistula cases did not provide as much information as was expected concerning the level of pelvic contraction below which spontaneous delivery becomes improbable. This was due to the fact that bladder trauma was sustained in the absence of a trained observer, and dystocia may have been due to factors other than small pelvis.

3. (*a*) In the series of primigravidae there were 14 pelves that had a plane area below 80 sq. cm., and 24 pelves with areas 80 to 90 sq. cm. The greatest cross-section of the well flexed Bantu foetal head has an area of 68.64 sq. cm. and it seemed reasonable to suppose that a pelvic area of 80 sq. cm. would be required for passage of the well flexed head.

(*b*) Twelve cases were sent to hospital, but only 5 had instrumental deliveries: 3 Caesarean sections and 2 forceps extractions.

4. The fact that Bantu women have delivered spontaneously with pelvic areas below 70 sq. cm. was unexpected. This and other features of the cases considered have led to the conclusion that the South African Negro as a parturient is greatly superior to the white woman. It has been suggested that the difference lies in the powers (uterine and other muscular action) which are used to the full in the Negro, but suffer a partial inhibition in the white woman.

5. Of 103 single pregnancies in primigravidae, 8 resulted in loss of the foetus.

There were 1 abortion, 3 macerated foetuses, 2 stillbirths in hospital; and on district 1 stillbirth and 1 infantile death an hour after birth.

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APPENDIX I.

Further Results to Test the Accuracy of the X-ray Method Described Previously.

In addition to the experiments in X-ray pelvimetry discussed by Heyns,[9] 20 dry Bantu female pelves were radiographed with the brim horizontal. The purpose of this was to find the accuracy of the modifications suggested for measuring the lengths of the inter-ischio-spinal diameter and the transverse of the brim, the area of the brim, and the brim index. The true measurements of these diameters and the planimeter area of the brims were known from precise measurement on the dried pelvis.

1. The greatest error for the interspinal diameter was −2.4 mm. in one case, the majority of errors being under 1 mm., and a few 1 to 2 mm. It was suggested previously that the error would rarely be more than 1 mm. The mean error was 0.0995 cm.: in 1 there was no error, in 5 there was a plus error, and in 14 a minus error.

2. For the brim transverse diameter, it was found in the 20 specimens that the average error was −0.589 cm. It was pointed out previously that the true brim transverse was never shown on the X-ray film, and that the outline of the brim on the film always represented a level of the pelvis near the cavity plane. It was suggested that the X-ray transverse diameter was about 7.5 mm. shorter than the brim transverse.

3. The modified true conjugate suggested showed a mean increase for 20 pelves of +0.289 cm. over the actual true conjugate. Against this there is a loss of 0.589 cm. for the transverse as explained in 2.

4. *Area of brim.* On the average (20 pelves) the calculated X-ray brim area was 6.39 sq. cm. less than the true planimeter area. For these pelves the mean planimeter area was 112.655 sq. cm. Therefore,

the mean percentage error of the calculated X-ray brim area is - 5.67.

5. *Area of cavity*. Here the X-ray area was less than the area calculated from bone measurements in half the cases, and more in half. The minus errors showed a greater total area. The mean error of - 1.5 sq. cm. is much smaller than the error for the brim.

6. *Brim index*. It will be observed that the brim index is in truth a "cavity" index. The conjugate diameter is on the average 3 mm. more than it should be, and the transverse 6 mm. less. Therefore, the index obtained must be a little higher than Turner's index. This suggests that a higher index will be found than is in fact the case. Thus in 65 dry pelves the index was 90.4 ± 2 with a range of 69.6 - 104.4. In 100 pregnant women the mean index was 93.6 ± 0.72 with range 79.7 - 121.2.

APPENDIX II.

Analysis of the dimensions of Bantu pelves referred to in this paper. Comparative figures have been given for the Bantu male and English urban and rural populations

Pelvic dimensions.	Origin	No. of observations	Mean	Standard deviation	Coeff. of variation per cent	Range
Conjugata vera (cm.)	B. Male	100	10.33±0.11	1.06	10.2	7.9 -12.8
	B. Female	66	10.76±0.10	0.80	7.6	9.1 -12.6
	B. Antenatal	100	10.59±0.08	0.81	7.7	8.2 -12.5
	B. Stereometric method	25	11.01			
	Rural E.	350	11.64	1.05	9.0	8.35-14.35
	London E.	509	11.83±0.04	1.0	8.5	8.7 -15.0
Transverse of brim (cm.)	B. Male	100	11.26±0.08	0.80	7.1	9.5 -13.3
	B. Female	67	11.96±0.10	0.89	6.5	9.8 -13.8
	B. Antenatal	100	11.34±0.08	0.78	6.9	9.15-13.0
	B. Stereometric method	25	12.07			
	Rural E.	350	13.23	0.76	5.8	11.0 -16.0
	London E.	509	13.06±0.03	0.7	5.4	10.9 -15.4
Inter-ischio-spinal diameter (cm.)	B. Male	100	8.05±0.07	0.72	8.9	6.2 -9.7
	B. Female	66	9.70±0.13	1.00	10.3	6.5 -12.4
	B. Antenatal	100	10.47±0.09	0.93	8.9	7.45-12.58
	B. Stereometric method	24	10.03			
	Rural E.	250	10.54	0.77	7.3	8.25-12.75
	London E.	376	9.95±0.04	0.71	7.1	7.5 -11.5
True area of inlet (sq. cm.) by planimeter	B. Male	100	99.35±1.32	13.16	13.2	70.4 -140.2
	B. Female	51	113.38±1.31	9.29	8.2	94.0 -135.8
Calculated area of inlet (sq. cm.)	B. Female	66	101.23±1.25	10.17	10.1	74.75-126.8
	B. Antenatal	100	99.33±1.21	12.09	12.2	66.6 -127.6
	B. Stereometric method	25	113.04			
	Rural E.	350	121.0	12.9	10.7	86.0 -162.0
	London E.	375	126.80±0.66	12.8	10.1	95.0 -165.0
Area of plane cavity (sq. cm.)	B. Male	100	89.56±1.22	12.24	13.7	58.8 -113.2
	B. Female	67	111.78±2.78	11.40	10.2	85.2 -135.2
	B. Antenatal	100	93.75±1.26	12.58	13.4	60.0 -121.9
	B. Stereometric method	25	104.82			

Pelvic dimensions.	Origin	No. of observations	Mean	Standard deviation	Coeff. of variation per cent	Range
Area of outlet (sq. cm.)	B. Male	100	63.27±0.82	8.24	13.0	43.8 – 88.4
	B. Female	65	88.80±1.52	12.30	13.8	58.1 –116.9
	B. Antenatal	65	100.12±1.88	15.12	15.1	64.5 –131.0
	B. Stereometric method	20	101.95			
	Rural E.	250	106.7	11.90	11.2	76.0 –142.0
	London E.	376	93.70±0.54	10.40	11.1	65.0 –120.0
Pubosacral diameter (cm.)	B. Male	100	10.05±0.07	0.73	7.3	8.3 – 11.7
	B. Female	66	11.65±0.10	0.80	6.9	10.0 – 13.5
	B. Antenatal	65	12.20±0.17	1.33	10.9	9.1 – 15.7
	B. Stereometric method	21	12.90			
	Rural E.	250	13.01	0.96	7.4	10.3 – 16.0
	London E.	376	11.97±0.04	0.86	7.2	9.5 – 14.5
Intertuberal diameter (cm.)	B. Male	100	8.13±0.11	1.12	13.8	5.5 – 10.3
	B. Female	67	10.20±0.16	1.30	12.6	6.6 – 13.2
	B. Antenatal	87	11.47±0.12	1.15	10.0	8.5 – 14.0
	B. Stereometric method	21	10.76			
	London E.	474	10.90±0.03	0.70	6.4	8.6 – 13.3
Lateral depth of pelvic basin (cm.)	B. Male L	100	9.31±0.05	0.55	5.9	7.7 – 10.5
	B. Male R.	100	9.27±0.05	0.55	5.9	7.7 – 10.5
	B. Female L	67	8.75±0.06	0.51	5.9	7.9 – 10.9
	B. Female R	67	8.77±0.07	0.56	6.3	7.9 – 11.1
	B. Antenatal	87	8.77±0.06	0.58	6.6	7.6 – 10.2
	B. Stereometric method	21	7.57			
Anterior depth of pelvic basin (cm.)	B. Antenatal	87	10.25±0.07	0.66	6.4	8.5 – 12.0
	B. Stereometric method	21	9.87			
Height of symphysis pubis (cm.)	B. Male	100	3.58±0.03	0.28	7.8	2.8 – 4.4
	B. Female	66	3.45±0.04	0.30	9.7	2.7 – 4.5
	B. Antenatal	87	3.27±0.04	0.40	12.2	2.5 – 4.2
	B. Stereometric method	19	2.96			
Pelvic brim index	B. Male	100	91.56±0.91	9.11	9.9	70.2 –117.0
	B. Female	65	90.35±1.02	8.20	9.1	69.6 –104.4
	B. Antenatal	100	93.60±0.72	7.20	7.7	79.7 –121.2
	B. Stereometric method	25	91.27			
	Rural E.	350	88.3	9.40	10.7	65.5 –113.5
	London E.	509	90.80±0.36	8.20	9.1	64.0 –115.0

B = Bantu L = Left R = Right E = English

NOTE: (1) The 100 males and 65 to 67 females are from skeletal material.
(2) The antenatal cases derive from the series described in this paper. X-ray pelvimetry was employed.
(3) The stereometric method was used as a variation to check the other X-ray data.
(4) The two English series are taken from Nicholson's report on a rural population, and Ince and Young's "London Women."
(5) Dioptographic tracings were made of the brims of the dry pelves and the precise areas found with a planimeter.

The Blood in Pregnancy

PART I. THE HAEMOGLOBIN LEVEL.

BY

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INTRODUCTION.

A BRIEF reference has been made in a previous paper[1] to the haemoglobin levels of pregnant women in 1944, and it was shown that the levels were higher than were those of a series of women examined in 1942.[2] In this paper the results obtained in the 2 series are considered in greater detail and an attempt made to discover what are the changes in the haemoglobin level which occur in healthy women during pregnancy.

In 1945 the Committee on Haemoglobin Surveys of the Medical Research Council published their report.[3] This includes a review of previous work on haemoglobin levels during pregnancy which will not be dealt with in detail here. But out of the considerable volume of published work on the subject the following points emerge and will be considered in this paper.

1. The haemoglobin level tends to fall during pregnancy. Whether this tendency is normal or is due to a failure to meet the increased demands of pregnancy is not certain. In the last month of pregnancy a rise in haemoglobin level may occur.
2. Age may affect the haemoglobin level.
3. Parity may influence the haemoglobin level.

DETAILS OF THE INVESTIGATION.

The women investigated were all from one Edinburgh antenatal clinic. This is a hospital clinic and women attend from the surrounding country as well as from the town. The economic standing of the women was good.

The first investigation was carried out in the summer of 1942 when 279 women were seen, 165 primiparae and 114 multiparae. Only one estimation was carried out on each woman. The ages of the women varied from 17 to 41. The second investigation was made throughout 1944. One hundred and eighty women were seen, 107 primiparae and 73 multiparae. Ninety-two of the women this time were seen more than once, so that in their case individual changes in haemoglobin level could be recorded. The number of cases investigated in each trimester of pregnancy is shown in Table I. Only one value was recorded in each trimester for any given woman, with the exception of the third trimester, when values after the 36th week were recorded separately. The ages of the women varied from 17 to 40.

The haemoglobin estimations were made on capillary blood obtained by finger prick.

The Haldane haemoglobinometer, standardized by the National Physical Laboratory, was used and the standard conditions observed in the early weeks being similar to those in the later weeks.

It was, however, found that the haemoglobin level of the older women fell more rapidly than did that of the younger ones. In Table II are shown the mean falls in different age groups, and it will be seen that the rate of fall increased steadily till the age of 35. In the final small group of women of 35 and over the variations were large and the mean probably not a true one.

TABLE I.

The Numbers of Pregnant Women Investigated.

	First trimester 7–13 weeks		Second trimester 14–26 weeks		Third trimester 27–36 weeks		37–40 weeks		Total	
1942										
First tests	50		115		114				279	
1944										
First tests	66	66	86	110	24	92	4	43	180	311
Repeats	—		24		68		39		131	

Since the relation between age and rate of fall in haemoglobin level was linear it was possible to find a regression coefficient, by the method of least squares, relating the change in haemoglobin per lunar month to age in years. This was found to be −0.11, with a standard error of 0.050. When the method was applied to test the significance of this result, it was found that $t = 2.24$ and $p = <0.05$. In other words, the probability of an increased fall with increasing age being due to chance was less than 5 in 100.

The regression coefficient also showed the extent to which age affected the change in haemoglobin level in this series of women. The coefficient of 0.11 meant that with every year of increasing age the percentage haemoglobin fell another 0.11 per month. Since the mean centre of the series was a

RESULTS.

recommended by the Haemoglobin Survey Committee were observed.

1. *Changes in the Haemoglobin Levels of Individual Women*, 1944.

Eighty-six of the 92 women were seen twice or more between the 7th and 36th weeks of pregnancy, and the difference between the first and last tests was recorded. Twenty-four of these women and 6 others were seen twice in the third trimester, the second time in the last 4 weeks, and the difference between these tests was recorded. To eliminate the effect of variations in the time between tests the results were calculated and are given as the mean change in haemoglobin in a lunar month (4 weeks).

(a) *7th to 36th week.*

A rise in haemoglobin level occurred in 10 of the 86 women. Three women showed no change and 73 a fall. The mean change of all women was 2.5 per cent Hb. per lunar month. The fall was constant in rate throughout pregnancy, the changes

fall of −2.5 per cent Hb. at age 26.9 years, it could be calculated that the expected monthly falls were 1.7 per cent Hb. at 20 years, 2.25 per cent Hb. at 25 years, 2.8 per cent Hb. at 30 years and 3.35 per cent Hb. at 35 years.

The multiparous women at first sight appeared to show a more rapid fall than the primiparae (Table II). Thus while 60 primiparae fell a mean of 2.15 per cent Hb. per month, the 26 multiparae fell a mean of 3.2 per cent Hb. When their ages were considered it was found that the primiparae had a mean age of 23.4 years, at which the expected fall was 2.1 per cent Hb. per month, while the multiparae had a mean age of 31.2 years at which the expected fall was 3 per cent Hb. per month. The greater fall of the multiparae was therefore due to their greater age.

TABLE II.

The Changes in Haemoglobin Level Occurring in Pregnant Women of Different Ages, 1944.

Age, years	Mean change in Hb. per cent per lunar month.			
	Primiparae	Multiparae	All degrees of parity	St. dev.
17–19	−0.75 (8)	—	−0.75 (8)	1.85
20–24	−1.6 (21)	−2.6 (4)	−1.8 (25)	2.3
25–29	−3.0 (20)	−2.05 (6)	−2.8 (26)	2.15
30–34	−3.9 (8)	−3.8 (6)	−3.8 (14)	2.5
35–40	+0.9 (3)	−3.7 (10)	−2.5 (13)	3.5
All ages, mean 26.9	−2.15 (60)	−3.2 (26)	−2.5 (86)	2.6*

* Variation for age allowed for.
Numbers of women in parenthesis.

(b) *37th to 40th weeks.*

Of the 30 women who were seen twice in the 3rd trimester, the second time in the final month, 10 showed a rise in haemoglobin level, 7 no change and 13 a fall. The mean change of all the women was −0.4 per cent Hb. per lunar month. Their mean age was 27 years.

Again it was found that the age could be correlated with the change found, but in contradistinction to the result in the earlier months, it was now found that while the younger women continued to show a fall in haemoglobin level the older ones did not show any change or a rise. The regression coefficient of change in haemoglobin percentage on age was +0.40 (standard error 0.17, t = 2.31, p = <0.05). In this series the effect of age was thus again significant. With a mean centre of −0.4 per cent Hb. at age 27 years, it was such that the expected change per lunar month was −3.2 per cent Hb. at 20 years, −1.2 per cent Hb. at 25 years, +0.8 per cent Hb. at 30 years and +2.8 per cent Hb. at 35 years.

2. *The Mean Haemoglobin Levels of Pregnant Women,* 1944.

While treatment of the results in the above manner is the most accurate method for determining whether changes in haemo-

globin level occur in pregnancy, the numbers seen were not large enough to give figures which could be applied more widely. In this part, therefore, the numbers have been increased by including the results obtained from a further 88 women who were seen once only. In the case of the women seen several times, when possible, one value was recorded in the first and one in the second trimester, one in the third trimester before the 36th week and one after the 36th week. In all 311 observations were made on 180 women—88 women being seen once, 58 twice, 29 three times and 5 four times.

The numbers seen in each trimester are shown in Table I. In Table III and Fig. 1 are shown the mean haemoglobin levels for each trimester and for the last month.

(a) *7th to 36th weeks.*

The haemoglobin level fell throughout this period—the mean value of the 66 estimations made in the first trimester was 87.8 per cent Hb.—that of the 110 in the second trimester 85 per cent Hb.—and that of the 92 in the first part of the third trimester 78.2 per cent Hb.

The effect of age in this series was best seen in the third trimester, by which time the greater fall of the older women had brought their haemoglobin levels to figures well below those of the younger ones. Thus

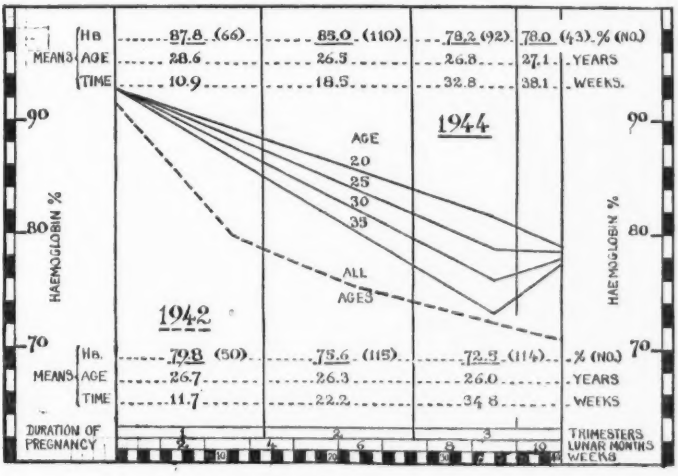

FIG. 1.

THE MEAN HAEMOGLOBIN LEVELS OF WOMEN DURING PREGNANCY.

The graph showing the mean changes in level for 1942 (interrupted line) is interpolated between the means for each trimester of pregnancy and that for non-pregnant women. The graphs for 1944 (entire lines) are, up to the 34th week calculated from the formula

Hb. = [92.75 − 0.064 (age × length of pregnancy in lunar months)] per cent

and those for the 34th to 40th weeks from the data on women seen in the last month.

when the 92 values found between the 27th and 36th weeks (mean time − 32.8 weeks), were considered, it was found that the regression coefficient of haemoglobin level on age was −0.5 (standard error 0.17, $t = 2.93$, $p = 0.01$). The difference due to

age was, therefore, significant and for each additional year of age the mean haemoglobin percentage was 0.5 less.

Similar regression coefficients could be obtained for the first and second trimesters, but as the differences here were smaller they were not significant when taken alone.

This method of grouping the results according to the trimester introduced artificial divisions and was inaccurate in that variations in the time of testing, within the trimester, were not allowed for. was in calendar months. There was no figure available to show the mean haemoglobin level of non-pregnant women in Edinburgh in 1944, but the mean centre of the series of pregnant women was 83.3 per cent Hb. at a mean age of 27.1 years and mean time of 5.4 lunar months, and by substituting these figures in the above formula, it became:

Mean Hb. = [92.75 - 0.064 (Age × length of pregnancy)] per cent.

Indirectly it thus appeared that the mean

TABLE III.

The Mean Haemoglobin Levels of Pregnant Women, 1942 and 1944.

Trimester	No. of estimations		Mean, time seen, weeks		Mean age, years		Mean Hb. per cent		Standard deviation	
1942										
1st.	(50)		11.7		26.7		79.8		8.7	
2nd.	(115)	279	22.2	25.2	26.3	26.25	75.6	75.1	8.7	
3rd.	(114)		34.8		26.0		72.5		9.6	
1944										
1st.	(66)		10.9		28.6		87.8		8.6	
2nd.	(110)	268	18.5	21.6	26.5	27.1	85.0	83.3	6.8	8.0*
3rd–36 weeks	(92)		32.8		26.8		78.2		10.0	
37–40 weeks	(43)		38.1		27.1		78.0		9.4	

* Variation for age and duration of pregnancy allowed for.

It was possible to consider all the results from the commencement of pregnancy up to the 36th week as one series in the following way. Since the haemoglobin level fell steadily during this time and since the fall was directly proportional to the age of the women, the mean haemoglobin level at any age and within this time could be expressed by the formula:

Mean Hb. + [Mean Hb. before pregnancy − C (Age × length of pregnancy)] per cent.

The constant C is the regression coefficient relating the haemoglobin level to (Age × length of pregnancy), and was found to be 0.064 (standard error = 0.007, t = 9.09), when the age was in years and the time in lunar months. It was 0.058 when the time haemoglobin level of these women before pregnancy would have been 92.75 per cent. This figure compared well with those given in the Haemoglobin Survey for 1943, which were 92.5 per cent Hb. for 2,974 married women and 94.4 per cent Hb. for 4,813 unmarried women.

From this equation, the mean haemoglobin level of this series of women at any stage of pregnancy up to the 36th week and at any age could be calculated. The results so obtained for various age groups are given in Table IV and are shown graphically in Fig. 1. By means of the formula it is possible to compare the haemoglobin level of this group of women with that of any other, when the ages and durations of pregnancy are known.

It must be noted that the formula only gives mean haemoglobin levels. It can be applied to groups of women, but not with accuracy to individual cases. Within the series there were large individual variations. This is shown by the fact that the standard deviation of the mean of the whole series of 268 estimations was +8 per cent Hb. Twenty-eight per cent of the women had haemoglobin levels which deviated from the expected by more than 8 per cent.

Examination of the effect of parity on the haemoglobin level affords an example of how the formula can be used. The mean figures for all values found in the first 36 weeks and also separately for those found between the 27th and 36th weeks, are shown in Table V, grouped according to parity. In the larger series the levels of the groups were very similar. Such small differences as were present were accounted for by variations in the length of pregnancy or age and the mean haemoglobin was in each case within 0.5 per cent Hb. of that found by calculation from the formula. In the group seen between the 27th and 36th weeks, the level of the primiparae was 4.5 per cent Hb. higher than that of the multiparae, but the true difference when age and duration of pregnancy were allowed for was only 1.3 per cent Hb. The standard error of the difference of the means was 1.9, which was greater than half 1.3; so the difference of 1.3 per cent Hb. was not significant. Thus again parity was not found to have a significant effect on the haemoglobin level.

(*b*) *37th to 40th weeks.*

The mean haemoglobin level of the 43 cases seen between the 36th and 40th weeks (mean time 38.1 weeks) was 78 per cent Hb. This value is the same as that found in the groups seen between the 27th and 36th weeks.

When the effect of age on the haemoglobin level was considered at this stage of pregnancy it was found to be less marked than earlier in the third trimester. The regression co-efficient of haemoglobin level on age was 0.25 (standard error = 0.25, $t = 0.95$, $p = 0.35$).

Thus the difference between yearly age groups in the last month was only 0.25 per cent Hb. as compared with 0.5 per cent Hb. earlier in the third trimester. It was not now statistically significant.

This result complements that found in the previous section when the effect of age on individual changes in haemoglobin level was considered. It was there shown that in the last weeks the rate of fall increased in the younger women, while the older women showed a rise. This suggested that any difference in haemoglobin level due to age which had become apparent in the first 36 weeks would tend to disappear in the last month. Here this has been shown to be so. It is probable that at term all ages would

TABLE IV.

The Expected Haemoglobin Levels in the Different Months of Pregnancy and at Different Ages.

	Hb. per cent Calendar months								
Age, years	1	2	3	4	5	6	7	8	9
20	92	91	89	88	86	85	83	82	80
25	92	90	88	87	85	83	81	79	79
30	92	90	88	85	83	81	79	77	77
35	92	89	87	84	81	79	76	74	76

have had the same mean haemoglobin level. The variations in the haemoglobin level with age are shown in the figure where the values found for the age groups 20, 25, 30 and 35 are shown separately.

3. *The Mean Haemoglobin Levels of Pregnant Women in* 1942.

The mean values found are shown in Table III and also in Fig. 1. The mean level in the 1st trimester was 79.8 per cent Hb. (50 cases), in the second 75.6 per cent Hb. (115 cases) and in the third 72.5 per cent Hb. (114 cases). In 1942 a series of 220 non-pregnant women was also investigated and their mean haemoglobin level was 91.6 per cent.

It is apparent from these figures that the haemoglobin level fell considerably throughout pregnancy, the most rapid fall occurring in the earlier months.

The mean values of the pregnant women were lower in 1942 than in 1944. In the first trimester the figures for 1942 and 1944 respectively were 79 per cent and 87 per cent Hb., and in the second trimester 75.6 per cent and 85 per cent Hb., and in the third trimester 72.5 per cent and 78.2 per cent Hb. The age of the subjects was again investigated but in this series it was not found to affect the haemoglobin level significantly. When the 114 cases seen in the third trimester were analysed a regression coefficient of haemoglobin level on age of 0.05 per cent Hb. for every year of age was obtained (standard error $=0.166$, $t=0.32$, $p=0.8$). This was not significant and similar results were obtained in the first two trimesters.

Another difference from the 1944 series was that there was no tendency for the haemoglobin level to rise towards the end of pregnancy. The 24 cases seen in the last month had a mean of 68.6 per cent Hb., while the 90 cases seen earlier in the third trimester had a mean of 73 per cent Hb.

In order to investigate the effect of parity in this 1942 series, it was necessary to find the haemoglobin level to be expected at different times throughout pregnancy. As the rate of fall was not constant, the relation between haemoglobin level and time was not linear. But since the rate did not alter markedly between the 3rd and 10th months, when most of the observations were made, the use of a linear regression coefficient did not introduce large inaccuracies. The regression coefficient of haemoglobin level on the duration of pregnancy, or the fall in haemoglobin per lunar month, was found to be 1.44 (standard error $=0.25$, $t=6.08$) and the mean expected haemoglobin level between the 3rd and 10th months was expressed by the formula:

Mean Hb. $=[X-(1.44\times$ length of pregnancy$)]$ per cent.

When the mean values were substituted X was found to be 84.2. Since age did not in 1942 affect the haemoglobin level it was not necessary to consider it.

The figures for women of different parity are shown in Table V. There was a slight difference between the levels of primiparae and of the women in their second pregnancy, but this was not significant. When the women who had already had 2 pregnancies were compared with the others, however, it was found that there was an apparent difference of 3.3 per cent Hb. and a real difference, when the duration of pregnancy was considered, of 3.5 per cent Hb. (standard error $=1.55$, $t=2.33$ and $p=0.02$). The difference was thus significant and it is apparent that in this series in 1942, women who had had 2 or more pregnancies previously, had a lower mean haemoglobin than had those in their first or second pregnancy.

Discussion.

It is clear that the results obtained in 1942 and 1944 were very different. They are

compared in Tables III and V and Fig. 1. The most obvious difference is that the mean haemoglobin levels in each trimester of pregnancy were lower in 1942 than in 1944. From this it appears that in 1942 a larger proportion of the cases were anaemic. This point has already been discussed by us.[1, 2] In 1944 there were still probably some cases of anaemia and the inclusion of their haemoglobin values will have lowered the mean values. This is most conclusive evidence is derived from observations made on the same women, throughout pregnancy, as was the case in the work of Kühnel,[6] Galloway,[7] Strauss and Castle,[8] Dieckmann and Wegner,[9] McGeorge,[10] Boycott[4] and Meyer-Wedell.[11] The extent of the fall in haemoglobin level in these series was in each case very similar to that found here, the lowest mean level being about 80 per cent Hb.

moglobin level which was proportional to the age and greatest in the oldest women, and which continued till the last few weeks of pregnancy. In these last weeks the level of the older women rose, so that at term the level was the same for all ages, but was still below that of non-pregnant women. Primiparae and multiparae behaved in a similar way.

The fall in haemoglobin level during pregnancy has been found repeatedly. The

TABLE V.

The Effect of Parity on the Haemoglobin Levels of Pregnant Women, 1942 and 1944.

	No. of estimations	Mean Hb. per cent (1)	Mean age years	Mean time lunar months	Expected Hb. per cent (2)	Difference, (1)–(2)
1942						
Primiparae	(165)	75.3	24.5	6.4	75.0	0.3
Para 1–	(75) (240)	75.1 75.2	27.6	6.2 6.3	75.2 75.1	−0.1 +0.1
Para 1+	(39)	71.9	29.5	6.2	75.3	−3.4
	Apparent diff.	3.3			True diff.	3.5
1944						
7–36 weeks						
Primiparae	(166)	83.6	25.1	5.5	83.6	0
Para 1	(55)	83.3	30.1	4.7	83.7	−0.4
Para 1+	(47)	82.4	31.0	5.2	82.2	+0.2
27–36 weeks						
Primiparae	(64)	79.6	24.9	8.2	79.5	+0.1
Multiparae	(28)	75.1	31.1	8.2	76.3	−1.2
	Apparent diff.	4.5			True diff.	1.3

supported by the fact that higher mean values have at times been found, as by Boycott in a series from which subjects with colour indices below 0.91 were excluded, and by McCance *et al.*[5] in a small series of well-to-do women. The incidence of true anaemia was, however, much lower in 1944 than in 1942 and the majority of the cases, it is suggested, then showed changes in haemoglobin level which were normal in direction if not in extent.

In 1944 there was a steady fall in the hae-

A rise in the haemoglobin level in the last month of pregnancy has also been fre-

quently noted.[4, 6, 9, 10, 11, 12] A higher level in the last month was also found in the 2 large series of single haemoglobin estimations during pregnancy reported by Fullerton,[13A] and the Haemoglobin Survey.[3]

In only one series has age been reported as influencing the haemoglobin level.[13] Since there are wide individual variations it is clear that the effect of age may be apparent only when large numbers are considered, nevertheless the fact that even in large series no effect has been found suggests that it may not be a constant feature.[4, 8, 13B]

A number of workers have investigated the effect of parity on the haemoglobin level and found no correlation.[3, 4, 7, 8, 13] Linder and Massey[14] reported lower values than in multiparae, but it is not clear that this effect was not due to age.

The conclusions drawn from the 1942 series were as follows. In this year the fall in haemoglobin level was greater, and more rapid in the early months of pregnancy than it was in 1944. Women of all ages were equally affected by the fall, which continued throughout pregnancy to term. Multiparae exhibited lower haemoglobin levels than primiparae.

A review of the literature shows very few series with haemoglobin levels similar to those found here in 1942. Goodall and Gottlieb[15] reported such a series and they also found that the multiparae had much lower values than the primiparae, but only when their pregnancies had occurred in close succession. Reid and Mackintosh[16] observed women in 2 income groups. In the higher the incidence of anaemia was slight and the number of pregnancies had no effect until women with 5 children were considered. In the lower income group, however, there was a high incidence of anaemia and multiparae of all grades showed lower levels than the primiparae.

Two practical points emerge from these results. The first is of importance when the haemoglobin levels of different series of pregnant women are being compared. It has been shown that the haemoglobin level falls during pregnancy and that the fall may vary with age and parity. It is therefore impossible to obtain an accurate comparison of different series unless all these factors are taken into account.

The second point is of interest to the obstetrician. The extent of the normal fall in haemoglobin level during pregnancy is still not definitely established, but it is suggested that the levels found in 1944 (shown in Table IV) approach the normal and may be used as standards until supplanted. Since there were large individual deviations from these mean values, at first sight it appears that it is not possible from these figures to predict the haemoglobin level of any individual during pregnancy with any useful degree of precision. But the deviations, when account was taken of length of pregnancy and age, were, in fact, no greater than those found in any series of normal people. Thus the standard deviation of the 1944 series of pregnant women, allowing for length of pregnancy and age, was 8 per cent Hb., while that of the haemoglobin of 1,115 single men, very few of whom were anaemic, was 9.02 per cent Hb. (Haemoglobin Survey, 1945). It therefore appears that the haemoglobin level can be predicted as accurately in pregnant women as in other groups, provided the above factors are considered.

Summary.

1. The haemoglobin levels of pregnant women in one antenatal clinic were investigated in 1942 and 1944. In 1944 the level of a number of women was followed throughout pregnancy.

2. In 1942 the haemoglobin level fell sharply in the first months and then more slowly to term. Women with 2 or more

previous pregnancies exhibited lower levels than the others. Age did not affect the level.

3. In 1944 there was a fall in the haemoglobin level during pregnancy but this was not so great as in 1942. The fall was proportional to the age of the women and was steady until the last few weeks, the level of the older women then rose, so that at term there was no difference between different age groups. Parity did not affect the haemoglobin level.

4. The changes in the haemoglobin level are discussed and the importance emphasized, of considering the effect of the duration of pregnancy, the age and the parity on the level.

5. The haemoglobin levels to be expected in the different months of pregnancy and at different ages are tabulated.

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Stillbirth and Neonatal Death : A Clinico-pathological Study

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FOETAL and neonatal deaths together number something in the region of 43,000 per year in England and Wales, and although the total infantile death-rate has shown a reduction in recent years, the immediate neonatal period is still the least satisfactory. Several papers have recently been published on various aspects of this problem, which in view of the risk of a decline in population due to a reduction in the average size of the family has important social, as well as medical, implications. The surveys in this country have tended to be on general lines, while in America the autopsy findings in several large series have been more fully analysed relative to the obstetric data.

This paper is based on 327 autopsies performed on foetuses and infants delivered in the maternity department of Crumpsall Hospital, Manchester, and on 46 autopsies on infants in the neonatal group at the Booth Hall Hospital for Sick Children, Manchester. The detailed obstetric history was known in all the Crumpsall cases and could be correlated with the postmortem findings. In no other group is the close collaboration of pathologist and clinician so essential: without the clinician the autopsy findings cannot be interpreted; without a pathological examination opinion on the cause of death is often little better than guess-work.

The series does not represent an even percentage of the total number of stillbirths and neonatal deaths occurring in Crumpsall Hospital during the 7 years under review, since, in the early years, the cases for autopsy were selected on account of some unusual clinical features and where the cause of death appeared obvious an autopsy was not done. Unfortunately, during this early period prematurity was too readily accepted as a cause of death without further examination, but during the 2 years an attempt has been made to have autopsies whenever possible. Therefore the figures and percentages given should be regarded as applying to this series only and not strictly representative of the total number of stillbirths and neonatal deaths occurring in the hospital. The figures for 1945, when 80 per cent of all the deaths were examined postmortem, are given for comparison with the full table.

It is necessary to define the terms used throughout this paper. The period covered is that between the viability of the foetus (taken as 28 weeks gestation) and the end of the 4th week of life. This arbitrary end-point is a convenient one, giving an approximate limit to the period in which birth factors may be expected to play their chief part. We have accepted the general opinion with regard to prematurity, that weight is the more reliable guide and any foetus or child weighing $5\frac{1}{2}$ pounds or less has been recorded as premature, although we realize

that sometimes immature would be a much more suitable term.

The arrangement of the tables follows closely that given by Potter and Adair[1] in their book "Fetal and Neonatal Death" in order to make possible a comparison with American figures. It is difficult to know how to state the cause of death in this age group since it is possible to classify the pathological findings in so many different ways. Asphyxia, for instance, may be due to intracranial haemorrhage, cord complications or prolonged labour, or may result from a severe congenital heart lesion, et cetera. The method adopted by Potter and Adair, of giving the chief pathological lesion responsible for death, is followed in this paper and although open to criticism it does enable any further factors to be considered under the main headings.

It will be noted that prematurity is not given as a primary cause of death. We agree with MacGregor[2] that prematurity should be considered either as a predisposing or a contributory factor in many deaths but seldom a satisfactory sole cause of death, and therefore prematurity is separately discussed as a factor which runs horizontally through the vertical groups into which we have divided our cases.

Table I gives a summary of the cases on which this paper is based.

Intracranial Haemorrhage (Table II).

There is no need in this paper to discuss the mode of causation of intracranial haemorrhage during labour, as this is well understood, but it is worth mentioning that if the head is not examined carefully and systematically at autopsy the evidence of intracranial injury may be destroyed. The head should be opened by cutting with scissors along the vertex on either side of the falx and removing the vault of the skull in two pieces: each cerebral hemisphere should be removed separately, noting any haemorrhage either on the surface of the brain or in its substance. This method gives a clear exposure of the whole of the falx and tentoria. We have not always found it easy to assess the amount of intracranial haemorrhage necessary to cause

TABLE I.

Causes of Death as Demonstrated at Autopsy.

373 cases: 223 livebirths: 150 stillbirths

	Crumpsall				Booth Hall			
	Stillbirth		Neonatal death					
Cause of death	Pre-mature	Full time	Pre-mature	Full time	Pre-mature	Full time	Total	Percentage
Haemorrhage	4	24	14	19	—	3	64	17.2
Asphyxia	25	49	12	15	—	—	101	27.1
Atelectasis	—	—	12	6	5	—	23	6.16
Intections	—	—	26	26	3	17	72	19.3
Miscellaneous (including erythroblastosis)	6	1	4	15	—	8	34	9.1
Congenital abnormalities ...	9	2	7	11	—	10	39	10.45
Placental insufficiency	2	2	—	—	—	—	4	1.07
No pathological change	12	14	6	4	—	—	36	9.65
Total	58	92	81	96	8	38	373	100.0

death, as it is often impossible to tell how must damage has been caused by pressure on the respiratory centre. Our opinion is that such haemorrhage should be fairly gross before one can be reasonably certain that it is the only lethal factor since we have occasionally seen signs of non-fatal intracranial haemorrhage in infants dying later from quite different conditions.

Where we have found intracrebral haemorrhage, not uncommonly into the ventricles, without any evidence of damage to the falx or tentoria, we have considered the cause of such haemorrhage to be asphyxia and have classified it as such.

The 64 cases in this series where intracranial haemorrhage was shown to be the cause of death formed 16.1 per cent of the total. Eardley Holland[3] in his series found that of the fresh foetuses examined 48 per cent of the deaths were due to intracranial haemorrhage, the majority of these being the result of breech delivery, forceps delivery, or delivery through a contracted pelvis: a few only resulted from normal cephalic delivery. Our cases show a very different distribution—14 resulting from forceps delivery, 7 from breech delivery, and 4 from internal version and breech extraction. This may be taken as definite evidence of improved obstetric practice resulting directly from Holland's work and in particular from the use of episiotomy in breech delivery, which he advocated so strongly.

It is of interest to note that in the remaining 39 cases (60 per cent) spontaneous vertex delivery had occurred. Of these there had been prolonged labour in 6, while in 1 there was a very rapid delivery. Labour had been induced by a combined drug induction (pituitrin in doses of 2.5 units but no quinine) and artificial rupture of the membranes in 4 of the cases. In the remaining 28 cases nothing abnormal was observed about the labour or delivery. A reduced foetal mortality from this cause in normal deliveries as it has been in breech deliveries, might be attained by a wider use of episiotomy. Holland pointed out the greater liability of the head of the premature foetus to tentorial tear, and in this series 18 were premature. Dr. Mary Crosse[4] has advocated episiotomy in the delivery of premature infants.

TABLE II.

Sixty-four Deaths due to Intracranial Haemorrhage

Type of labour	Stillbirths		Neonatal deaths	
	Premature	Full time	Premature	Full time
Normal cephalic	2	8	9	9
Prolonged or difficult labour	-	3	-	3
Induction of labour	-	3	-	1
Quick second stage	-	-	-	1
Forceps	-	7	1	6
Breech	2	2	3	-
Version and extraction	-	1	1	2
Caesarean section	-	-	-	-
Total	4	24	14	22

Asphyxia (Table III).

This is a condition in which the foetus dies from lack of oxygen and, since it is completely dependent on the oxygen it receives

TABLE III.

Analysis of 101 Deaths due to Asphyxia.

	Normal cephalic				Forceps				Breech				Version and extraction				Caesarean section			
	S.B.		N.D.		S.B.		N.D.		S.B.		N.D.		S.B.		N.D.		S.B.		N.D.	
	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.
Accidental antepartum haemorrhage	7	5	–	2	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Placenta praevia	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	2
Prolonged labour ...	–	1	–	2	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Cord complications ...	3	12	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Toxaemia in mother ...	6	5	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Medical complications ...	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
No maternal complications	6	14	5	7	–	2	1	–	1	–	–	–	–	4	–	–	–	1	–	–

S.B. = Stillbirth.
N.D. = Neonatal death.
P. = Premature.
F.T. = Full time.

through the cord from the placenta, various complications may arise to interfere with this supply either before or during labour, resulting in stillbirth, or the damage to the infant may be so severe that it survives birth for only a short time. As would be expected, therefore, this group of 101 cases (36 per cent of the whole) is the largest in the series. Seventy-four of these were stillbirths and 27 livebirths.

The subject has been reviewed recently by Parsons,[5] and MacGregor[2] and from our experience we agree with their general observations. In this paper we will limit ourselves to analysing the various obstetric factors which contributed to death. The autopsy findings were characteristic but very variable in extent; dusky skin, general engorgement of the veins, petechial haemorrhages, especially beneath the visceral pleura and in the thymus, haemorrhages of varying size beneath the epicardium on the surface of the heart, and occasionally more massive haemorrhage into the brain or adrenals. We have placed in a separate group as examples of atelectasis, cases where the lung has failed to expand but where none of the signs of asphyxia were found at autopsy, although we agree with MacGregor that most of these cases are probably asphyxial in origin.

In Table III the deaths in this group have been separated according to the type of labour and other obstetric findings. In 24 there was accidental antepartum haemorrhage or placenta praevia, and asphyxia was due to interference with the blood supply at the placental end. Definite toxaemia in the mother was present in 14 and in many of these there was a sufficient degree of placental insufficiency due to infarction to cause asphyxia in the child; prolonged labour leading to foetal distress was a factor in another 7 cases.

More controversial perhaps is the group of 17 where the asphyxia has been attributed to cord complications. It is generally accepted that a prolapsed cord will result in death of the foetus unless conditions are favourable for immediate delivery. The question of the effect of a cord found tightly wound round the neck is more open to discussion. In recent correspondence in the *British Medical Journal*[6] the view has been expressed that a cord twisted round the neck of the foetus was seldom if ever the cause of death, since the placental insertion moved down during labour and therefore the cord was not unduly stretched. This is not our view. We have had in this series macerated and fresh foetuses showing evidence of asphyxia in which there seems no doubt that the cord wound tightly round the neck was the cause of foetal death. This has occurred in spite of the usual precautions of feeling for the cord after delivery of the head and slipping the cord over the head or dividing it between forceps.

In a large proportion of cases (41 out of 101) no cause for the asphyxial signs was found, in spite of a careful review of the obstetric details. Probably a certain number of these could have been prevented by a more careful auscultation of the foetal heart during the second stage of labour.

The part which morphia, hyocine and the barbiturates may play in the production of asphyxia is well recognized. However, careful examination of all the case records in this group showed that none of these things had been used.

Atelectasis (Table IV).

In this group we have included 23 infants, most of them dying within a few hours of birth but some surviving in a precarious condition for several days. The important finding in this group, which we have called atelectasis, was that the lungs, or at least large portions of them, had failed to expand. Very commonly the lungs as a whole seemed solid and sank in water but there

were generally a few patches of emphysema, sometimes bullous, on the free margins. It is admitted that the same factors may operate here as those which result in asphyxia and the difference may be only one of degree, but it has been thought worth while to differentiate between the two types of case. We have excluded from the atelectasis group any with the classical signs of asphyxia or haemorrhage or any in which we have demonstrated evidence of lung infection microscopically. Prematurity was undoubtedly the important factor in 17 of these 23 cases. MacGregor[2] said that atelectasis should never be given as a cause of death and that the so-called cases were really examples of asphyxia through depression of the respiratory centre during birth and inhalation of liquor amnii, meconium or vernix. It is quite likely that depression of the respiratory centre may be the cause, at least it cannot be denied, but in the group we are discussing there were no signs of asphyxia and no indication of insufflation.

TABLE IV.
Atelectasis 23 Cases.

	Natural cephalic	Forceps	Breech	Version and extraction	Caesarean section
Premature	16	1	–	–	–
Full time	5	1	–	–	–

A systematic examination of the lungs of these infants makes one realize afresh the unreliability of the "floating test" as evidence of livebirth, in spite of the fact that it is still largely relied upon for medico-legal purposes to prove that the child has or has not breathed. We have had cases in this series where the lungs and all portions of them have sunk completely in water and where the child has survived birth for some 2 or 3 hours and been heard to cry; we have also had examples of lungs floating well when the clinical evidence was that the child was stillborn, and therefore respiration must have taken place during birth. It is essential in doubtful cases to examine the lungs microscopically for evidence both of aeration and insufflation and even this evidence may not be conclusive.

Infections (Table V).

Infections present a different problem from the conditions so far discussed, as here the maternal condition and obstetric history, apart from prematurity, are not usually determining factors. The infections are important, not only because of the high percentage of neonatal deaths which they cause, but because during the last few years it has been felt that a reduction of mortality from infection should be well within reach.

From the Registrar General's figures, two facts emerge: (1) Although there has been a very welcome reduetion of some 20 per cent in infantile mortality during the last 10 years, the worst group is still that of infants between 1 and 4 weeks old. (2) The total infantile mortality in 1943 for England and Wales, at 49 per 1,000 livebirths compares unfavourably with the figure of 31 for New Zealand and 30 for New York City. The conditions most responsible for the difference are enteritis and diarrhoea, bronchitis and pneumonia: in short they are all infections.

In the present series infection is considered to have been responsible for 72 (19.3 per cent) of all the deaths or 31.7 per cent of those in the neonatal group. Other writers give the following incidence of infections as the cause of death: Adair *et al.*[7] 8.7 per cent in 483 neonatal deaths: Bundesen *et al*[8] 10.3 per cent of 1,043 infants less than 14 days old: Gibberd[9] 12 per cent, although it is not clearly stated whether these are autopsy figures: MacGregor[2] 40 per cent; McNeil[10] 27 per cent

and Henderson[11] 22 per cent. These figures are sufficient to show that if a child survives the hazards of birth the risk of infection is its greatest danger, and this danger is enhanced if the child is premature.

Table V shows that more than half the deaths were due to infections of the respiratory tract, and more generally staphylococcal. Many of these occurred in the 1st week and the majority within the first 2 weeks of life. To assess the true incidence of lung infections it is essential to take swabs for culture at the time of the autopsy and to examine sections of the lungs microscopically, as naked-eye appearances alone may be fallacious. The lungs sometimes show multiple small abscesses; often, especially in prematures, the lung is dark red in colour and completely solid. Benians[12] has shown how soon the skin and nasal passages of an infant acquire staphylococci and in weakly babies with the liability to inhale particles of food, and lungs which are often imperfectly expanded, the conditions are very favourable for staphylococcal infection. Evidence of aspiration was present in a few but we consider most to have been due to airborne infection. There seems little doubt that the risk of infection is greater in hospital than it is in the home, and with the present preference for institutional midwifery the problem is one of increasing importance. Penicillin might give favourable results and is now being tried. The diagnosis is admittedly so difficult and the progress of the disease so rapid that penicillin will have to be given very early if it is to be effective. We have come to the conclusion that it is justifiable to give penicillin as soon as an infant, especially if premature, begins to go off its food, which is the first sign of danger. In Crumpsall Hospital the babies, except the prematures, are nursed in cots at the side of the mother's bed, and not packed closely together in nurseries. At present there is no special premature nursery and the premature infants are nursed in the ward nurseries, where the accommodation is insufficient and unsuitable in many respects. A new premature unit has been planned, based on the principles outlined by Dr. Mary Crosse of Birmingham.[4]

TABLE V.
Analysis of Infections.

Type of infection	Premature	Full time
Lung infections	24	18
Gastro-enteritis	1	5
Meningitis	–	4
Infections of urinary tract ...	–	3
Peritonitis (cause not found)	–	3
Paralytic ileus	–	2
Umbilical sepsis	–	2
Staphylococcal skin infections	–	3
Osteomyelitis	–	1
Staphylococcal endocarditis	1	–
Thrush	1	–
Streptococcal nasopharyngitis	1	–
Congenital syphilis	1	1
Encephalitis	–	1
Total	29	43

A note on the other infections may now be made. Gastro-enteritis has occurred only once in the Crumpsall series, and there have been but 5 cases at Booth Hall Children's Hospital in the age group under consideration. This may be due to the fact that the babies in Crumpsall Hospital have been almost entirely breast fed and the prematures have been fed on expressed breast milk, but it is realized that a small epidemic of enteritis, such as recently occurred in other hospitals in the Manchester area, might easily upset these figures.

There were 4 cases of meningitis, 2 pneumococcal and 2 due to *Bacterium coli*. MacGregor[2] has noted that in young infants *Bacterium coli* has unusual invasive powers not generally seen at a later age.

Congenital syphilis, histologically confirmed, accounted for only 2 deaths and a

similar low incidence has been noted by most recent writers on neonatal infection. It contrasts with Holland's series, where 16 per cent of his stillbirths were thought to be due to congenital syphilis.

Two interesting infections were an osteomyelitis of the femur in an infant of 3 days and a staphylococcal endocarditis in one of 11 days.

Purulent peritonitis, for which a primary cause was not found and in which the umbilicus did not show signs of infection, accounted for 3 deaths and in another 2 cases there was well-developed paralytic ileus, presumably infective, but without any obvious primary focus.

Neonatal infection was reviewed by Parsons in his Charles West Lecture in 1943, and the findings in our series merely serve to emphasize the truth of his observations.

TABLE VI.

Miscellaneous Causes of Death. 34 *Cases.*

Cause of death	Stillbirth		Neonatal death		
	Pre-mature	Full time	Pre-mature	Full time	
				Crumpsall	Booth Hall
Erythroblastosis foetalis (icterus gravis)	3	–	1	10	6
Hydrops foetalis	1	–	2	–	–
Haemorrhagic disease of newborn	–	–	–	1	1
Thrombosis of renal veins	–	–	–	1	–
Jaundice (cause not ascertained)	–	–	1	–	–
Polyserositis	–	1	–	–	–
Reticulo-sarcoma of thorax	–	–	–	–	1
Toxaemic changes in liver	2	–	–	2	–

Miscellaneous Causes of Death (*Table VI*).

In Table I there is a miscellaneous column which includes 34 cases fully analysed in Table VI. It will be seen that 20 of these deaths, 3 stillborn and 17 neonatal, fall into one group of erythroblastosis foetalis (icterus gravis type) and there are in addition 3 cases of hydrops foetalis which is generally regarded as a more advanced manifestation of the same condition. The earlier cases were diagnosed as icterus gravis on clinical and histological grounds, but since the discovery of the Rh factor it has been possible to establish a more certain diagnosis, and in 9 of the later cases the opinion has been confirmed serologically. Death took place most often in the first few days of life and as one would expect the condition generally occurred in a second or later child. The relative frequency of erythroblastosis (accounting for approximately 6 per cent of all the deaths investigated) and the fact that prompt recognition and immediate treatment are essential, has led us to adopt the following routine:

(1) Every woman attending the antenatal clinic has her red cells tested for the Rh factor, and if Rh negative her serum is examined during the last few weeks of pregnancy for the presence of Rh antibodies.

(2) Any Rh negative mothers, found to have anti-Rh agglutinins in their serum, should be admitted to hospital for the last month of pregnancy, and if there is a rise in the agglutinin-titre labour should be induced.

(3) Special watch is kept on the infants born to these Rh negative women and if the child shows any sign of jaundice its blood is immediately tested for the Rh

factor and the haemoglobin estimated. Transfusion, with Rh negative blood, is given if there is any significant fall in the haemoglobin level and transfusion is repeated if necessary using the haemoglobin level as a guide.

(4) All blood taken from donors is tested for the Rh factor and in this way a panel of Rh negative donors, available for both mother and child, is gradually being formed.

By these methods it has already been possible to save several infants suffering from erythroblastosis, in some cases where an earlier child of the same parents has died from this condition. It is impossible at present to say whether all these children will be normal in every way as there is a risk of kernicterus and possibly of mental deficiency, but it does seem that this is a group for which much may be done in the future.

There were only 2 cases of haemorrhagic disease, both intestinal haemorrhages, probably due to vitamin K deficiency.

Two tumours were found in the series, a neuroblastoma of the adrenal in a child of 18 days (an incidental finding and not a cause of death) and a reticulosarcoma of the thorax in a child of 2 days.

It has generally been accepted that toxaemia in the mother may influence the child chiefly through placental infarction and placental insufficiency leading to asphyxia, but 4 of our cases suggest that occasionally the toxins circulating in the mother's blood may pass through the placenta and cause damage to the liver of the child. Two were stillborn and 2 were neonatal deaths and the mothers had definite toxaemia. In 1 the liver changes were similar to those found in women dying of toxaemia of pregnancy; 2 showed extensive generalized fatty change and 1 severe cloudy swelling with nuclear degenerative changes.

Congenital Abnormalities.

These are set out in Table VII. It is not necessary here to deal with these in any detail as they represent what is probably the irreducible residue of foetal and neonatal deaths for which nothing can be done. It has recently been suggested that some

TABLE VII.

Distribution of 39 Congenital Abnormalities.

Type of abnormality	Stillbirths		Neonatal deaths	
	Premature	Full time	Premature	Full time
Congenital heart	–	1	1	11
Diaphragmatic hernia	1	–	3	–
Anencephaly	4	1	–	–
Hydrocephalus and spina bifida	1	–	–	1
Hydrocephalus	1	–	–	–
Atresia of oesophagus	–	–	–	1
Multiple deformities	2	–	1	3
Hydronephrosis	–	–	1	1
Maldevelopment of kidney	–	–	1	–
Atresia of intestinal tract	–	–	–	3
Cleft palate (with bronchopneumonia)	–	–	–	1
Totals	9	2	7	21

congenital abnormalities might be associated with rubella infection of the mother during the first 3 months of pregnancy. We have made careful enquiries among the mothers of children showing these abnormalities: a history of rubella has not been obtained in the 25 we have been able to trace.

The malformations account for 10.7 per cent of all the deaths. In the literature it is striking that the percentage of congenital abnormalities recorded is extremely variable and when such figures as 30 per cent are given it strongly suggests that the series is unduly selective and that an excessive proportion of cases likely to be of special interest have been included. To some extent, therefore, the percentage of these abnormalities may be an indication of the extent to which any given series is truly representative, and judged by this criterion our figures are not unduly biased. Reference is made to this point in the section dealing with the figures for 1945.

Autopsies in which the Cause of Death was not Determined.

Lastly we come to the group set out in Table VIII where the cause of death was not found at autopsy. In a few of these it was known that the mother suffered from toxaemia, syphilis or diabetes which did not cause any pathological lesions in the foetus. It is quite possible that some deaths in this group might be due to placental insufficiency, since in the early stages of this investigation examination of the placenta was not made. The rest in this group are evidence of our ignorance of the pathology of this period of life. Help was not obtained from the obstetric history since the majority were associated with normal cephalic deliveries.

Consideration of the Figures for the Year 1945.

It is instructive to consider separately the autopsy results for the year 1945 and to correlate them with the total births for that year:

Stillbirths		Livebirths		Total births	
Premature	Full time	Premature	Full time	Premature	Full time
59	40	201	2064	260	2104
99		2265		2364	

This gives a total stillbirth incidence of 99 in 2,364 (41.8 per 1,000) and a prema-

TABLE VIII.

Thirty-six Autopsies where Cause of Death was not Determined.

Type of delivery	Normal cephalic				Forceps				Breech				Version and extraction				Caesarean Section			
Maternal condition	S.B.		N.D.		S.B.		N.D.		S.B.		N.D.		S.B.		N.D.		S.B.		N.D.	
	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.	P.	F.T.
Toxaemia	3	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Syphilis	1	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Diabetes	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–
No maternal complications	7	7	3	3	–	–	–	–	1	2	1	–	–	–	–	–	–	1	–	–

S.B. = Stillbirths.
N.D. = Neonatal death.
P. = Premature.
F.T. = Full time.

ture stillbirth incidence of 59 in 260 (227 per 1,000).

For the same period there were 79 neonatal deaths, 54 premature and 25 full time.

The neonatal death-incidence was therefore 79 in 2,265 (34.9 per 1,000 livebirths), and the premature neonatal death-incidence 54 in 201 (269 per 1,000 livebirths).

These figures show the large part played by prematurity in the stillbirth and neonatal mortality-rates. Of the combined stillbirths and neonatal deaths 59 and 54 respectively were premature, i.e. 63.59 per cent.

During this year an attempt was made to increase the numbers of postmortems performed; consequently 63 of the 99 stillbirths and 67 of the 79 neonatal deaths were so examined and the findings are summarized in Table IX.

unfortunate that an autopsy was not performed in 100 per cent of the cases because it is only in this way that a true idea can be obtained of the relative incidence of the various factors involved. The records of the 36 stillbirths and 12 neonatal deaths which had not received full postmortem examination were therefore summarized and the result given in Table X.

Of these it is seen that 13 are recorded as gross congenital abnormalities, 12 being anencephalic and 1 hydrocephalic with spina bifida. It seems justifiable to add these 13 to the list of postmortems performed thereby obtaining for the year a more accurate picture of the relative incidence of the various causes of foetal death. When this is done it is found that congenital malformation accounts for approximately 20

TABLE IX.

Cause of Death as Demonstrated at Autopsy (Year 1945 only).

Cause of death	Stillbirth		Neonatal death		Total	Percentage
	Premature	Full time	Premature	Full time		
Haemorrhage	1	4	9	4	18	13.85
Asphyxia	18	16	9	4	47	36.2
Atelectasis	—	—	2	—	2	1.54
Infections	—	—	17	9	26	20.0
Miscellaneous (including erythroblastosis)	1	—	2	1	4	3.08
Congenital abnormality	5	3	2	5	15	11.5
Placental insufficiency	2	2	—	—	4	3.08
No pathological change	6	5	3	—	14	10.77
Total	33	30	44	23	130	100.0

The percentage incidence of the pathological findings at autopsy is seen to be very similar to that for the whole series as given in Table I. One very obvious difference is that of the 130 cases in Table IX; 77, i.e. 59.2 per cent, were premature, whereas for the whole series only 31.6 per cent were premature. This is explained by the fact that in the early years very few premature bodies were examined. It is

per cent of the total figure, which is still very much lower than that given in many publications.

DISCUSSION.

A comparison between Table I and Table IX shows that for the whole series of autopsies pathological lesions were not found in 36 per cent, while for 1945 this figure was 11 per cent. We feel that this is

chiefly due to our greater experience in interpreting the postmortem changes.

Finding a cause of death is more satisfactory than having to record a negative postmortem result, but it is the search for the determining factors in some of these deaths which is obviously most important. In this we, in common with most other writers, have been only partially successful and, especially in the asphyxia and atelectasis groups, the mode of delivery and the maternal condition by no means always give a satisfactory explanation. The tables themselves and the remarks we have made under the various headings will emphasize this. What is undoubtedly significant, running parallel through most of the groups is the influence of prematurity, most pronounced where death was due to asphyxia, atelectasis or infection. Baird[13] has recently discussed some of the factors involved in prematurity and he notes how much more frequent this condition is in the lower income groups owing to the poor health and nutrition of the mother. Most of our cases were in these lower income groups and if Baird's analysis of the position is accepted, the remedy lies in measures directed to improving the general standard of living of these mothers together with special measures for nursing premature infants. Prematurity is so important a factor in many of these deaths that we feel that premature labour should only be induced for very definite reasons and should whenever possible be delayed until the gestation has reached 34 to 36 weeks.

TABLE X.

Forty-eight Cases During Year 1945 not Examined Postmortem.

	Stillbirths	
	Premature	Full time
Gross congenital abnormalities ...	11	2
Cord complications	3	3
Toxaemia	2	1
Toxaemia and diabetes	—	1
Accidental antepartum haemorrhage	2	1
Placenta praevia	1	—
Destructive operation	—	1
Cause not known	4	2
Maternal syphilis	2	—
	Neonatal deaths	
	Premature	Full time
Internal version and breech extraction	—	1
Lived under 24 hours	7	—
Lived over 24 hours	4	—

It may be profitable to consider again the groups we have adopted in this paper to see if any particular measures are available for reducing the mortality rate.

(*a*) Intracranial haemorrhage. It is in a sense disappointing that many deaths due to this cause followed normal cephalic deliveries in which no other known factor was involved. An episiotomy would save some of the premature foetuses and it is probable that the same operation, followed if necessary by a low forceps delivery which could all be done with local anaesthesia, might prevent some of the others.

(*b*) Asphyxia and atelectasis. Prematurity is the largest single factor and has already been discussed. No less than 43 per cent of these 2 groups were premature. Many of the cases in these groups are due to antepartum haemorrhage and are largely unavoidable. While this is true also of cord complications, i.e. prolapse and cord round the neck, it is probable that many which fall into this category together with some of the unexplained ones could be prevented by careful auscultation of the foetal heart in the second stage. Steps could then be taken to hasten the delivery if this was indicated and if the conditions were favourable.

(*c*) Infections. Here there is very definite

room for improvement. Again prematurity is an important factor and much more may yet be done to protect the premature child from infection during the critical first few weeks of life. Parsons has epitomized much that has been written and said on this subject and his advice means the provision of adequate accommodation and facilities for the child as well as the mother in all maternity departments and more careful nursing than has been available in the past. The reduction of infection of the respiratory tract, which accounts for a high proportion of the deaths investigated here should be possible and the establishment of nurseries for the premature staffed by specially trained nurses are an immediate necessity.

(*d*) Erythroblastosis. The discovery of the Rh factor has opened a new field for the diagnosis and treatment of erythroblastosis, a condition which accounted for 6 per cent of the deaths investigated. We have indicated that the routine examination of the blood of all pregnant women for the Rh factor, careful watch on the infants of Rh negative mothers and prompt treatment with Rh negative blood if the child shows signs of haemolytic disease, are the measures necessary. We know from personal experience that many of these children can be saved; we do not yet know what proportion of these children will show evidence of mental deficiency resulting from kernicterus.

(*e*) Congenital abnormalities. It should be possible to reach a decision on the question of the relationship between rubella and other infectious diseases in the mother and the incidence of congenital defects, especially cardiac, in the child. In this very small number we have not had any supporting evidence. We understand that the Ministry of Health has undertaken to collect figures and preventive measures must await more definite evidence than has yet been produced.

SUMMARY.

1. This paper is based on an analysis of autopsy findings in 373 cases of stillbirth and neonatal death, correlated with observations of the mode of delivery and any relevant maternal conditions.

2. A separate analysis of figures for 1 year is given for comparison with the full series.

3. The importance of prematurity in relation to many of the deaths in this age group is again stressed.

4. Infection, especially in premature infants, is one of the most important factors in neonatal death.

5. The value of episiotomy is noted and its extended use for the prevention of stillbirth and neonatal death suggested.

6. Erythroblastosis foetalis is discussed and a routine suggested for the diagnosis and treatment of this condition.

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Primary Carcinoma of the Fallopian Tube

(A Report of Four Cases)

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PRIMARY carcinoma of the Fallopian tube is a rare condition and, although the volume of literature on the subject has increased considerably in recent years, most of it has come from Continental and American clinics.

There has been little written on the condition in English journals for many years, and in view of the recent cases seen by members of the staff of this hospital, it was considered worth while:

(1) To add a further 4 cases to the literature;

(2) To review the literature as fully as wartime deficiencies would allow, and

(3) To analyse some of the more recently reported cases in an effort to present a comprehensive picture of the condition.

HISTORICAL.

There seems little doubt that the first authentic case of the disease was reported by Orthmann[1] in 1886. With this statement both Baron[2] and Martzloff[3] agree.

Henderson,[4] however, gives priority to Orthmann as writing in 1888, as do Lofgren and Dockerty.[5] In the paper to which these authorities are referring,[6] Orthmann mentions the cases of Senger and Gottschalk described in 1886, both however diagnosed as tubal sarcomata with metastases in the pouch of Douglas. In the absence of adequate pathological evidence both these cases are of doubtful authenticity. Orthmann presents 13 cases collected from the literature, but dismisses them all as examples of secondary tubal involvement. The only case he accepts as authentic is his own, described in 1886.

Several authors[7, 8] writing before Orthmann had suggested that carcinoma of the Fallopian tube might arise as a separate disease entity, and Rokitansky[9] gave a good pathological description in 1861. The claims made for Raynaud, as the reporter of the first case in 1847 by several writers including Robinson,[10] Jeanneney and Soubiran[11] and more recently Addis,[35] appear to be without foundation.

In 1895 Sanger and Barth[12] collected 17 cases previously reported in the literature, but dismissed several of them as cases of papillomata of the Fallopian tube.

The first case reported in England was that of Doran in 1888.[13]

INCIDENCE.

The number of cases reported is difficult to estimate because, as Martzloff[3] showed, some cases have been reported twice and others overlooked.

By 1903 Peham[14] had collected 63 cases. This figure rose to 84 in 1906 (Orthmann),[15] 100 in 1910 (Doran),[16] and 244 by 1929 (Wharton and Krock).[17] Nurnberger col-

lected 301 cases occurring between 1886 and 1931. Kahn and Norris,[18] however, had only quoted 270 cases by 1934. Robinson in 1935 accepted Nurnberger's figures, collected 48 further cases from the literature, added one of his own, and so brought the total to about 350. Martzloff by 1938 had added 32 cases from the literature and one of his own, bringing the total to 383.

By the end of 1944 the total of reported cases was about 450.

Since 1944 the writer has been able to collect only the case reported by Ayre,[19] and the 16 from the Mayo Clinic, some of which had previously been reported by Holland, and 3 reported by Addis. Including therefore the 4 cases here presented, the probable total is nearer 465 and the 376 quoted by McGoldrick.[20]

The rate of occurrence quoted by many authorities in a disease as rare as this can be of little value. Figures are given varying as widely as 5 cases in 35,000 gynaecological admissions at the University of Pennsylvania,[17] to 1 per cent in 995 gynaecological admissions at the Frauenklinik Berlin (Schmit).

Of the 4 cases quoted in this paper, Cases 1 and 4 are the only ones known to have occurred in this hospital during the past 25 years, the total number of patients admitted to the gynaecological department being 9881. Martzloff gives the rate of occurrence as 0.5 per cent of operative procedures on the Fallopian tubes.

Perhaps the truest estimate of frequency is that of Cameron: "The condition is so rare that many gynaecologists never see it."

Case Reports.

Case 1.

A married woman, aged 48 years, with 2 children, had enjoyed excellent health until 1 year before admission, when she noticed a swelling of the abdomen unaccompanied by pain. Six months before admission her abdomen enlarged rapidly and she was admitted on March 16th, 1925, under the care of Mr. Victor Bonney.

On examination a mass was found to fill the pelvis, the nature of which it was impossible to determine. On March 19th the abdomen was opened; both Fallopian tubes were enormously dilated and bound to the uterus by light adhesions. The remaining pelvic contents appeared normal. Primary carcinoma of the Fallopian tubes was suspected, and the uterus and both tubes and ovaries were removed. The patient made an uneventful recovery and was discharged home. She was re-admitted on March 26th, 1926, having noticed a hard lump in the abdomen and considerable swelling since November 1925.

Seventeen pints of bloodstained fluid were removed by tapping, after which a lower abdominal mass and enlarged spleen were both readily palpable. The patient was discharged on June 24th, 1926, and died at home in August of the same year, 16 months after the original operation. A post-mortem examination was not performed.

Pathological report. The specimen removed consisted of the uterus and both Fallopian tubes and ovaries. The ovaries and uterus were normal both macro- and microscopically. Both Fallopian tubes were dilated to about 1 inch in diameter—the left to form a large cyst at its fimbriated end. Both tubes were adherent to the superior and posterior surfaces of the uterus. The inner surfaces of the Fallopian tubes were covered by numerous thick papillary masses, which coalesced in places to form solid tumours. Microscopically there was invasion of all coats by tubular carcinoma with solid areas of polygonal cells (Fig. 1).

Case 2.

A married woman, aged 38 years, had suffered from heavy and irregular periods for 1 year. Ten months before admission she noticed pain in the back at the onset of her periods. She was admitted to hospital on September 24th, 1945, under the care of Mr. W. R. Winterton, with a provisional diagnosis of uterine fibroids. On admission, it was noticed that she had marked lower abdominal tenderness, and a large polyp was seen protruding through the cervix. Laparotomy on September 25th, 1945, revealed a distended left Fallopian tube adherent to the omentum and surrounding structures; otherwise the pelvis was normal. The left

Fallopian tube and ovary were removed, and some small fibroids by myomectomy. The abdomen was then closed, and the cervical polyp was twisted off *per vaginam*. The patient made an uneventful recovery and was discharged on October 15th, 1945. She subsequently attended the radiotherapy department of this hospital, and received a total tumour dose of 3528 R and deep X-radiation to the pelvis over 5 fields in a total of 28 treatments.

When last seen on April 17th, 1946, she was in excellent health and the pelvis appeared normal.

Pathological Report. The specimen consisted of a distended Fallopian tube sealed at the fimbriated end, with a normal ovary attached. On incision, the Fallopian tube showed mild fibrosis and one small papillomatous growth in its outer third. Microscopically the tube showed marked chronic inflammatory changes with an area of invasion by mainly undifferentiated polygonal cell carcinoma, but some attempted tubule formation.

CASE 3.

A married woman, aged 60, first sought advice because of continuous vaginal haemorrhage for 18 months. For the last year she had suffered from severe backache, worse in the early morning. She had had 7 children and 2 miscarriages. On examination abnormal physical signs were not detected, except for a symptomless enlargement of the thyroid gland, present, she said, for at least 30 years. She was admitted to hospital on January 11th, 1946, under the care of Mr. Carnac Rivett. At laparotomy, a tumour the size of a walnut was detected in the outer third of the left Fallopian tube. It was sealed at its fimbriated end, and there were filmy pelvic adhesions present. A diagnosis of probable carcinoma of the Fallopian tube was made, and total hysterectomy and left salpingo-oophorectomy performed. Local or distant metastases were not detected. She made an uneventful recovery, and was discharged one month after admission. Deep X-radiation was not given. The patient's goitre rapidly became toxic which necessitated a partial thyroidectomy 2 months later. Pathologically this was an adenoma of the thyroid. When last seen she was in excellent health and there was no evidence of recurrence.

Pathological Report. The specimen consisted of the uterus and left tube and ovary. The uterus and left ovary were normal macro- and microscopically. The left Fallopian tube showed a solid tumour the size of a walnut in its outer third. The rest of the tube was normal in appearance (Fig. 2). It was sealed at its fimbriated end. Microscopically there was invasion of the coats of the Fallopian tube by papillary carcinoma. The greater part of the growth appeared regular and well differentiated, but mitoses were frequent. (Fig. 3.)

CASE 4.

A married woman, aged 49, nulliparous, complained of continuous pain in the left iliac fossa for 6 months, accompanied by acute exacerbations. A white creamy discharge had been present for a year. Six months before admission her periods had ceased, except for two recent small losses of blood. She had noticed pain occasionally shooting down the inner aspect of the left thigh. She was admitted under the care of Mr. Carnac Rivett, on the 12th February, 1946, and on examination a large abdominal tumour arising from the pelvis and reaching to the level of the umbilicus was discovered. Fluctuation was elicited bimanually and a diagnosis of ovarian cyst was made. At laparotomy an enormously dilated left Fallopian tube was discovered, adherent to the uterus, pelvic colon, and side wall of the pelvis. In attempting to free it, it ruptured, and a few ml. of opalescent fluid escaped into the general peritoneal cavity. The left tube was finally freed and removed, together with the right ovary and slightly dilated right Fallopian tube, and the uterus by subtotal hysterectomy. The patient made an uninterrupted recovery and was discharged 25 days later. When last seen she was in good health and there was no evidence of recurrence. Postoperative radiotherapy was not given.

Pathological Report. The specimen consisted of the body of the uterus, a mildly dilated right tube and macroscopically normal ovary, and an enormously dilated left tube and small ovary of normal appearance.

The right tube showed a hydrosalpinx with fibrotic changes in the wall only. The left tube was greatly enlarged, and contained a large papillary growth at its fimbrial end, a central dilated portion

free of growth and a second papillary growth at the uterine end of the tube (Fig 5.) Both growths were wholly confined within the tube; both ovaries and the uterus were microscopically normal. Microscopically there was irregular papillary overgrowth of lining epithelium with invasion of deeper tissues by polygonal celled carcinoma. The cells of the growth were small and undifferentiated in character (Fig. 4).

Aetiology. An extensive search through the literature has thrown little light on this. There is an abundance of theory with little factual support. There is general agreement that it is a disease with its heaviest incidence at the menopause and the years immediately succeeding it. Cases have, however, been reported as young as 18 (Johnson and Miller[21]) and as old as 80 (Fullerton[22]). Wechsler[23] states that 66 per cent of cases occur in the age group 45–55. Of the 33 cases recently analysed, 22 fell into the age group 45–60.

The part played by previous inflammation as an aetiological factor finds support in the writings of Doran, Sanger and Barth and Orthmann, and more recently Ewing.[24] Ruge and Vest (quoted by Barrows[25]), and more recently Fullerton, Hobbs[26] and McGoldrick deny any such association.

Vest[27] considered that inflammation was the result rather than the cause of carcinoma of the Fallopian tube. The modern view is perhaps best summarized by Frankl[28] writing in 1914: " If inflammation were to be a precursor of carcinoma of the tube, the incidence of malignancy should be much higher, for salpingitis is overwhelmingly common." Of the 33 cases analysed, there were very few in whom there was good evidence of previous tubal inflammation.

Von Franque (quoted by Baron), L'Esperance[29], and more recently Ewing, and Lofgren and Dockerty point to cases where tuberculosis has also been present in the tube. Fullerton, however, suggests that some of these cases have been confused histologically, and stresses the occasional microscopical similarity between the two conditions. Douglass and Faulkner[30] go so far as to state that quite a few cases diagnosed as carcinoma are actually tuberculous. They suggest that tubal tuberculosis might predispose to papillomata, a supposedly pre-cancerous condition. The influence of parity and fertility on the condition is impossible to assess. Whitehouse and Doran state that it is more common in the parous than non-parous, a view not upheld by most recent authors.

Wharton[31] has recently suggested that the great infrequency of tubal carcinoma as compared with carcinoma of the cervix and uterine body may be associated with the different activities undertaken by the relative mucosal linings. He draws attention to the fact that the endometrium and the cervical mucous membrane are constantly altering throughout menstrual life, whereas the lining of the Fallopian tube remains relatively quiescent. The tubal mucous membrane is also much less subject to trauma. In view of this statement it is interesting to remember that many of these tumours arise in the postmenopausal years when the whole genital tract is relatively quiescent.

Pathology.

Carcinoma of the tube usually arises in the middle or outer portions of the tube. According to McGoldrick 70 per cent occur at the fimbriated end and 30 per cent at the isthmus. In the latter situation he considers that the prognosis is worse. Case 4 in this paper shows one tumour mass present at the isthmus and one at the fimbriated end. There is also a small nodule occupying the middle third. The spread in this case was almost certainly via the lumen of the Fallopian tube.

The fimbriated end is often sealed quite early in the disease; this is thought to im-

prove the prognosis in some cases by preventing dissemination throughout the general peritoneal cavity. In the 4 cases here presented the fimbriated end was sealed.

The condition is bilateral in about one-third of the total cases. The growth varies in size from a small malignant plaque (Case 2) to a large fungating mass that may or may not be still limited to the tube (Case 4).

In the past it was usual to describe 3 types of growth, the papillary, the adenomatous and the alveolar; but now the view is widely held that these types are merely stages in a continuous pathological process, the adenomatous and alveolar types arising by compression of the papillae in the papillary type (Phaneuf[32] and Ewing).

It should be noted that the term adenocarcinoma is an unfortunate one, there being no true glands in the Fallopian tube.

The malignant process bursts through the muscular wall of the tube only as a late event, although widespread lymphatic metastases may occur from quite well-circumscribed growths (Corbet[33]). Of the 33 cases studied in the literature, at the time of operation there were only 3 cases with evidence of intraperitoneal metastases, and in 2 of these the inguinal glands were involved. This is important in view of the long period that usually elapses between the first symptoms and diagnosis.

Spread may occasionally occur through the abdominal ostium to give rise to a carcinomatosis peritonei and ascites. Other modes of spread are via the round ligaments to the inguinal nodes via the lymphatics to the iliac and aortic glands, and via the blood stream to the liver and lungs. Secondaries have also been reported in the cervical and supraclavicular glands.

The ovary is only rarely involved in a growth that is primarily tubal, though spread to the uterus via the lumen of the tube may occur.

Secondaries may occur in the cervix and vagina, perhaps the most distressing case being that reported by Henderson where a secondary deposit appeared in the cervix 2 years after a successful subtotal hysterectomy and bilateral salpingo-oöphorectomy. It is interesting to note that of 33 recently reported cases, only 3 had to be abandoned surgically because of the spread of the growth.

Physical Signs.

The physical signs in this condition are seldom characteristic. It is possible that a combination of them may raise the suspicion of carcinoma of the tube. Very few correct preoperative diagnoses have been made.

The triad of lower abdominal pain (often of a colicky nature), watery or bloodstained vaginal discharge sometimes varying in amount with the colic, and a lateral pelvic mass, should arouse suspicion of tubal malignancy.

Of the 33 patients reviewed, 11 complained of abdominal pain, 9 had vaginal discharge, 8 had " post-menopausal bleeding ", and 8 had some upset of menstrual function. A mass was present in 21 out of 33 cases, but in only 2 was there also discharge and abdominal pain.

The onset of the disease is often very insidious, the first sign may be a change in menstrual habit before the menopause or heavy bleeding if the condition occurs after the menopause. The duration of symptoms varies from less than 1 month to more than 2 years.

The presence of associated pathological lesions in the pelvis add to the difficulty of diagnosis. Doran found ascites present in 2 cases in his series of 127, fibroids in 5 per cent, and ovarian cysts in 10 per cent. Out

of 33 cases, 3 cases of fibroids were found, and 1 ovarian cyst, in all cases responsible for obscuring the diagnosis.

Hobbs lays most stress on a sero-sanguineous discharge as a diagnostic aid, especially if it is associated with tubal colic (*hydrops tubae profluens*). He states that this is only present in 1 of 3 conditions: uterine carcinoma, tubal torsion or carcinoma of the tube. A discharge obviously of uterine origin that persists after curettage should suggest tubal malignancy.[20] These points would be of more value if most cases presented with vaginal discharge. Unfortunately this is not so. If there is an adnexal swelling of doubtful nature in the pouch of Douglas, posterior colpotomy and the possible recovery of malignant cells, might settle an otherwise doubtful diagnosis.[2] According to Hoenig and Warner[34] the conditions that are most often confused with carcinoma of the tube are menopausal bleeding, ovarian cysts, salpingitis, endometriosis, ectopic gestation, carcinoma of the uterus and ovary and granulosa-cell tumours of the ovary. A careful clinical examination and history may obviate many of these diagnoses, and a negative curettage with persistent bleeding is suggestive. A presumptive diagnosis of extrauterine pregnancy and granulosa-cell tumour of the ovary can often be made on the appearances of the curettings. Hormonal assay may also be of value in differentiating granulosa-cell tumours. In spite of this, however, Wharton and Krock doubt whether a correct diagnosis can be made when the disease arises in the childbearing period of life.

The presence of ascites is uncommon with carcinoma of the tube, in contradistinction to carcinoma of the ovary. In only 2 of 33 collected cases was ascites present. Hysterosalpingography may be of value in diagnosis. The risk of forcing cancerous material into the general peritoneal cavity is apparently minimal. A positive diagnosis of carcinoma of the tube cannot be made on a hysterosalpingography, but it may be useful in ruling out various intrauterine pathological conditions that show as filling defects.

A correct pre-operative diagnosis was made in only 2 of the 33 collected cases. Looking at these cases in retrospect it seems unlikely that it was possible to reach a correct diagnosis. The 4 cases described here could hardly have been diagnosed correctly in view of the obscure and confusing clinical picture.

Treatment and Prognosis.

Total hysterectomy and bilateral salpingo-oöphorectomy is agreed by most authorities to be the correct preliminary method of treatment. There is, however, no universal agreement on the place of radiotherapy in after treatment. Many authors including Baron, Phaneuf and more recently McGoldrick and Lofgren and Dockerty, are in favour of postoperative, deep X-radiation. Wharton and Krock question its value, and Martzloff states that there is no evidence that deep X-ray therapy is of any value. He points out that the number of cases treated is small, and that the period between treatment and assessment of its value is often too brief for any conclusions to be drawn. He collected 22 cases treated by X-rays from the literature; of these, 10 were dead and 8 alive, of whom 5 had been alive less than 1 year, and in 7 the outcome was not stated. There are, on the other hand, cases that have lived for many years without X-ray therapy. The outlook, whatever the treatment, is bad. Many of the survival-figures are of no value as the cases have not been adequately followed up and the time of survival is often not stated. The overall 5-year cure-rate is probably not more than 4 per cent.

This bad prognosis is due to a number of factors of which late diagnosis and inadequate surgical removal are probably the most important. The extreme malignancy of the condition is obviously a contributory factor. Until clinicians bear the condition in mind in every case of obscure adnexal disease, few additions are likely to be made to the 8 correctly diagnosed cases in the literature. Wharton and Krock state that in only a third of the reported cases was the extent of the surgery adequate. This is sometimes due to a misdiagnosis being made at laparotomy, a state of affairs that may be remedied by the practice of opening in the theatre all Fallopian tubes removed, and the submission of doubtful areas of frozen section.

Hobbs appears to be the only authority who advises the conservation of the uterus at operation, so that it may be used for the postoperative insertion of radium. All the 33 cases collected from the literature were treated by surgery in the first instance. Only 3 cases were abandoned as beyond surgical aid. In several an inadequate operation was done, and in 2 cases the abdomen was reopened and a more radical procedure carried out. In others, including Case 2 of this personal series, it was considered that the disease was in an early limited stage and further surgery was unwarranted. It is impossible to say whether further surgery added anything to the survival of these few cases. Ten of the 33 cases had deep X-radiotherapy, 1 both before and after operation, and 1 in combination with intrauterine radium.

Of the 10 cases treated by radiotherapy, 5 were alive at periods varying from 6 months to 4 years, and 5 had died, all within 2 years. Of the 23 cases treated by surgery alone, 6 were alive for periods varying from 1 month to 15 years, 7 had died all in under 4 years, and in 10 the end result was not stated. From figures such as these it is impossible to draw any conclusions except to suggest that both forms of treatment will probably give poor results until the diagnosis can be made more rapidly and with greater certainty.

Summary.

Four cases of carcinoma of the Fallopian tube are presented. Two cases (1 and 4) are from the records of Middlesex Hospital, and are the only cases known to have occurred there during the past 25 years. The other 2 (Cases 2 and 3) have been under the care of members of the staff and have been followed up at this hospital.

The recent literature has been scrutinized and 33 reported cases analysed.

Several points emerge:

1. The difficulty of diagnosis of the disease.

2. The bad prognosis in almost all cases.

3. The inadequate surgery to which many of the cases were subjected.

4. The doubtful value of deep X-ray therapy.

In none of the 4 reported cases was a correct clinical diagnosis made, and only twice in the collected group of 33.

The difficulty of preoperative diagnosis does not seem capable of resolution until the condition is more frequently borne in mind by clinicians, and doubtful cases in which symptoms persist after palliative treatment are subjected to laparotomy. Hysterosalpingography may occasionally be of value in differential diagnosis.

Radical surgery is undoubtedly the best line of treatment. Mistakes in diagnosis after the abdomen has been opened can easily be rectified by opening all Fallopian tubes removed and subjecting doubtful areas to frozen section. This procedure might also rule out the occasional case where the abdomen has to be opened for a second time to complete a radical clearance.

The value of deep X-rays is at best doubtful, as might be expected from the histological nature of the growth. Sufficient cases, however, have not been treated and followed up for a final judgment to be reached on their efficacy.

The suggestion is made that only by bearing the condition in mind in cases of unusual difficulty, early resort to laparotomy in unresponsive cases and employment of radical surgery in established cases, will the present high mortality be lowered.

My thanks are due to Mr. Victor Bonney, Mr. L. Carnac Rivett, and Mr. W. R. Winterton under whose care the patients were treated, for permission to publish this report; to the Bland-Sutton Institute of Pathology for permission to make use of the pathological material; to Dr. G. D. Hadley, T. R. Pilkington and Dr. Japha for their help with the foreign literature; and to Mr. W. H. Cheavin for his photographs.

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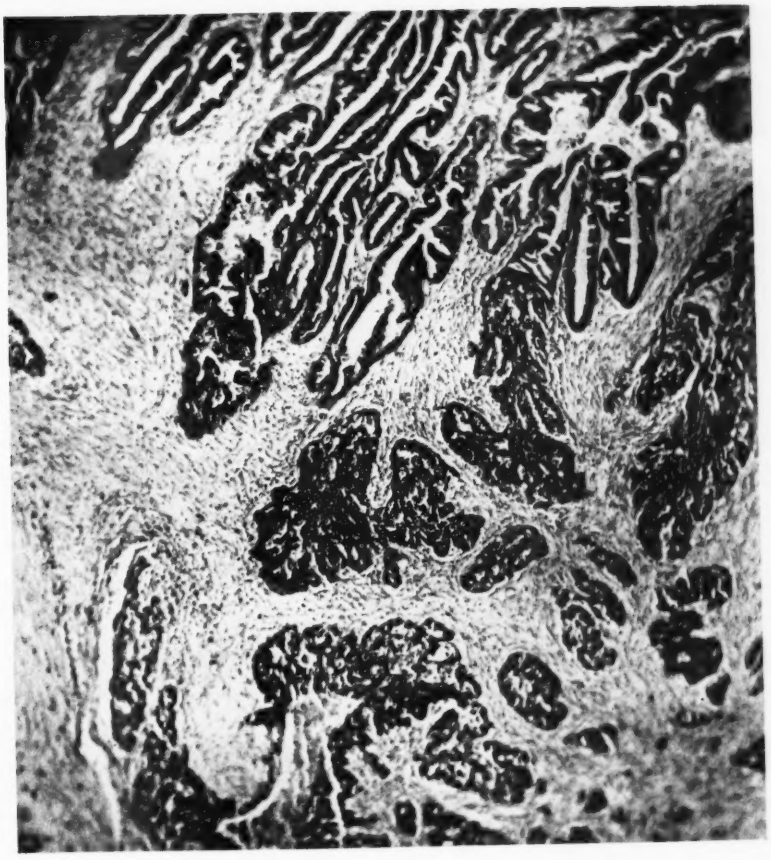

FIG. 1.

CASE 1. Showing at top right a somewhat hypertrophic mucous membrane. Centre and bottom shows invasion by solid areas of malignant cells.

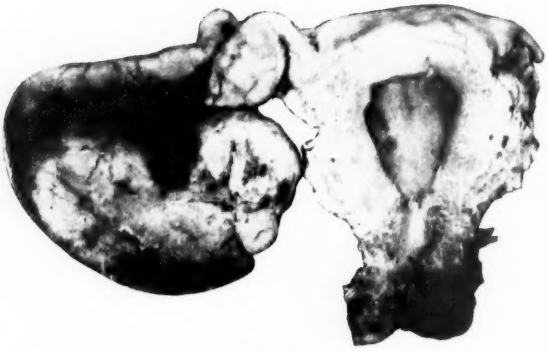

FIG. 2.

CASE 3. Showing normal uterus cut in coronal plane, and distal half of left Fallopian tube distended by soft, white encapsulated growth.

G. B.-L.

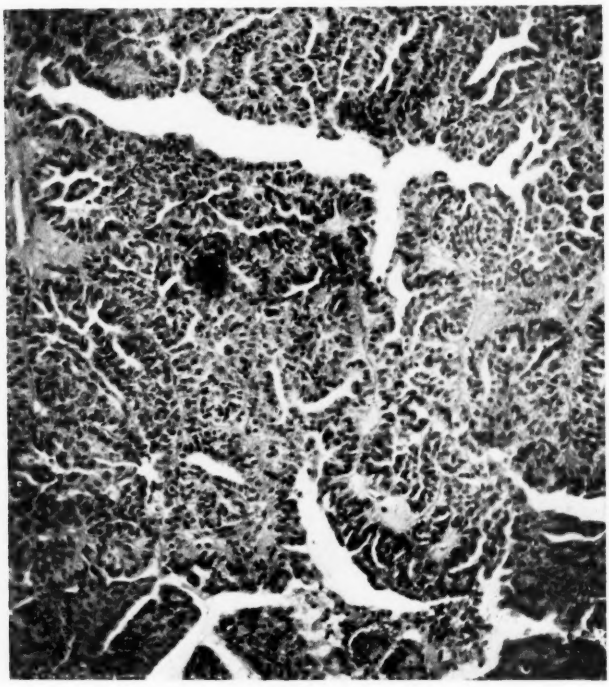

FIG. 3.

CASE 3. Showing invasion of the wall of the Fallopian tube by papillary carcinoma.

G. B.-L.

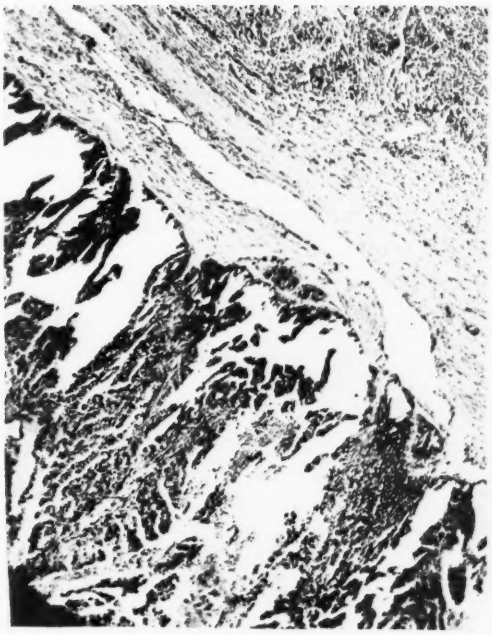

FIG. 4.

CASE 4. Showing hypertrophic malignant mucous membrane below left, and invasion of submucous layer by undifferentiated malignant cells above.

G. B.-L.

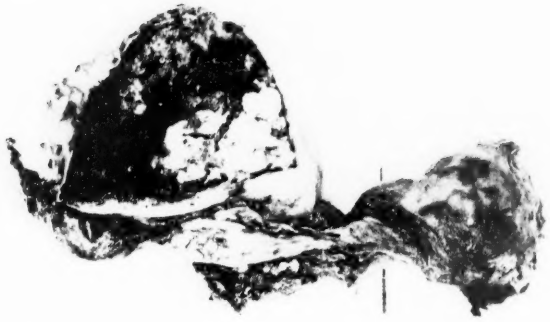

FIG. 5.

CASE 4. Normal atrophic uterus on right, with dilated left Fallopian tube filled with white necrotic growth.

G. B.-L.

Weather Changes and Eclampsia

BY

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PRE-ECLAMPSIA is a relatively common disease of late pregnancy, while eclampsia, which supervenes in a few of these cases, is uncommon. The incidence of eclampsia varies greatly in different parts of the world (Dieckmann[1]). In Cape Town the disease occurs more frequently than in most other centres.

There is generally believed to be a seasonal incidence for eclampsia, and many obstetricians are of the opinion that a change in the weather is one factor which may be of importance. According to Dieckmann sudden meteorological changes may cause eclampsia in the susceptible individual. Arnell[2] recently stated that local atmospheric changes seem to furnish the only obvious common factor where eclampsia occurs in groups after long intervals without a case. Meteorograms studied at the time of onset of seizures of antepartum eclampsia showed that in 83 per cent (62 cases) the onset coincided with a rising barometric pressure, a decreasing environmental temperature and a high degree of humidity. In 6 instances tropical electrical storms were also present. Theobald[3] has pointed out that the toxaemias of pregnancy are rare in Siam, and that the incidence of eclampsia in Ceylon is perhaps the highest in the world; yet the meteorological and living conditions are very similar in the two countries.

The weather has not been claimed to have any causal significance but may precipitate the patient with pre-eclampsia into convulsions or coma; this may result from contraction of the skin capillaries and a rise in blood-pressure while prevention of loss of heat and water would intensify the oedema. Abrupt changes in the physical milieu may accordingly require physiological adjustments beyond the capabilities of the abnormal individual.

A study of reports in the literature reveals much contradiction in the meteorological factors considered to predispose to eclampsia. This is well shown in Table I, modified from Dieckmann. In some reports only a few cases were studied, and statements have often been made based on impressions rather than on proper scientific evidence.

It was of interest to study records in Cape Town because the incidence of eclampsia is high, especially in the winter months—July to September—and because there is the impression that weather changes play some part. The incidence in Cape Town for the years 1925–34 has previously been published by Crichton[4] and Goldberg.[5] The monthly incidence of eclampsia in Cape Town for the years 1938–42 is shown in Table II; the table shows what appears to be a seasonal incidence, although the incidence of antepartum cases alone does not show any striking difference over the various months. Dieckmann reported different months of prevalence for different regions of the earth.

Since factors such as labour, operative procedures, et cetera, complicate intrapartum and postpartum eclampsia, only cases of antepartum eclampsia have been considered here. The records of 63 cases

TABLE I.

Author	Meteorological factors favouring eclampsia
Das	Temperature and humidity at a minimum
Sachweh	Warm and moist weather
Croom	Cold, rainy weather, with relative humidity high
v. Konrad	High humidity
Goldberg	High humidity
Merletti and Grappa	No relation to temperature. Barometric pressure, humidity and electric charge of the air important
Tottenham	Temperature low, humidity low (below 80 per cent)
Mitra and Ghosh	Maximum temperature important, humidity and rainfall unimportant
Bradford	Hot, wet climate
Fuestner and Sargent	Most cases correlated with the passing of a " cold " front
Arnell	Decreasing temperature, rising barometric pressure, and high humidity

TABLE II.
Peninsula Maternity Hospital.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	Total cases of eclampsia (White and coloured)											
1938	1	2	2	3	3	1	2	4	6	0	1	1
1939	2	0	1	1	0	2	4	5	4	3	1	1
1940	1	1	2	3	2	1	3	3	1	2	3	0
1941	1	2	1	2	2	1	6	0	4	6	0	3
1942	3	2	1	1	1	2	3	1	1	2	2	1
Totals	8	7	7	10	8	7	18	13	16	13	7	6
	Cases of antepartum eclampsia											
1938	1	2	1	1	2	1	1	0	1	0	0	0
1939	1	0	0	0	0	0	2	1	2	1	0	1
1940	1	0	0	2	2	1	1	3	0	2	3	0
1941	0	1	0	1	2	0	3	0	3	2	0	2
1942	0	2	0	0	0	1	0	1	0	0	0	0
Totals	3	5	1	4	6	3	7	5	6	5	3	3

of this type admitted to the Peninsula Maternity Hospital during 1938–43 were available for study, of which 45 were coloured patients (22 primiparae) and 18 were white (10 primiparae). An opportunity was taken while in Johannesburg (altitude 5,740 feet) to study the records of 20 cases of antepartum eclampsia (white) admitted to the Queen Victoria Hospital during the period 1937–43. In each of the cases the time of onset of the first convulsion was known, and was studied in relation to the meteorological events (maximum and minimum temperatures, barometric pressure, humidity) for the day of onset and the preceding 4 or 5 days.

Weather charts prepared for 45 of the cases in Cape Town are presented in Fig. 1. In each chart the variations in daily maximum temperature are indicated at the top

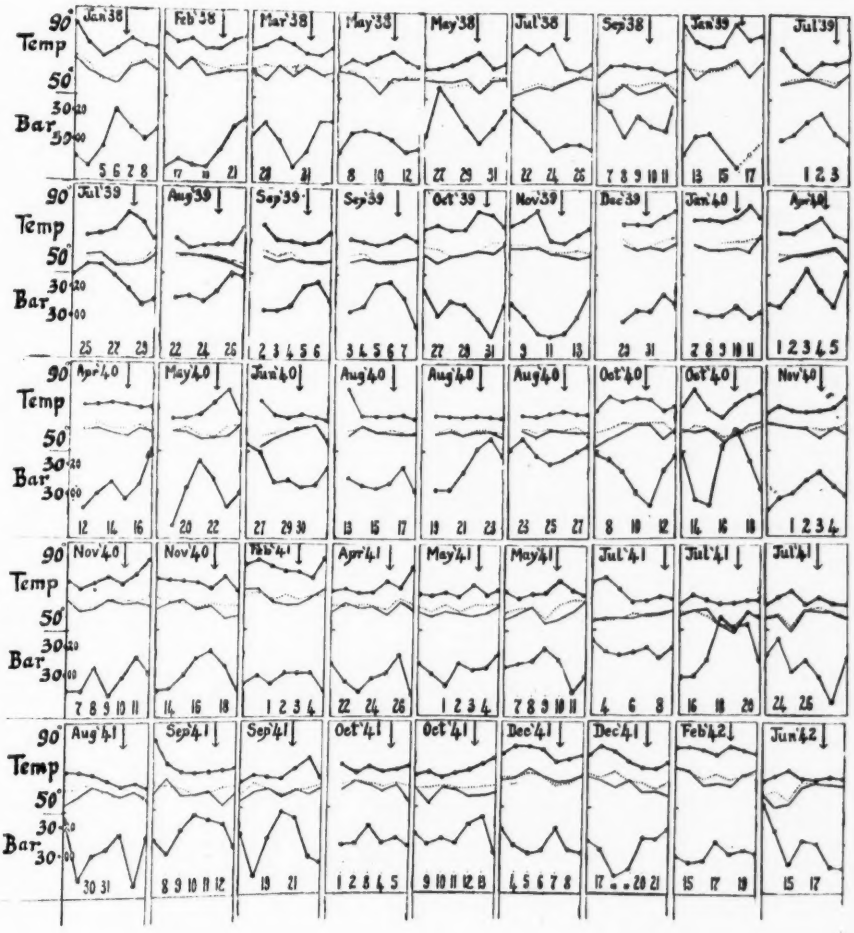

FIG. 1.

Meteorograms of 45 cases of Eclampsia.
Peninsula Maternity Hospital, Cape Town, 1938-43.

of the record, the minimum temperature just below this, the barometric pressure at the bottom of each record, and wet-bulb readings are indicated by a dotted line. Weather charts for the 20 cases in Johannesburg are shown in Fig. 2; in each case the maximum temperature readings are indicated by the heavy line, the barometric pressure by the dotted line, and the humidity by the interrupted line below. The vertical arrows show the time of onset of the first antepartum convulsion, the date being given in the figures at the top or bottom of each meteorogram.

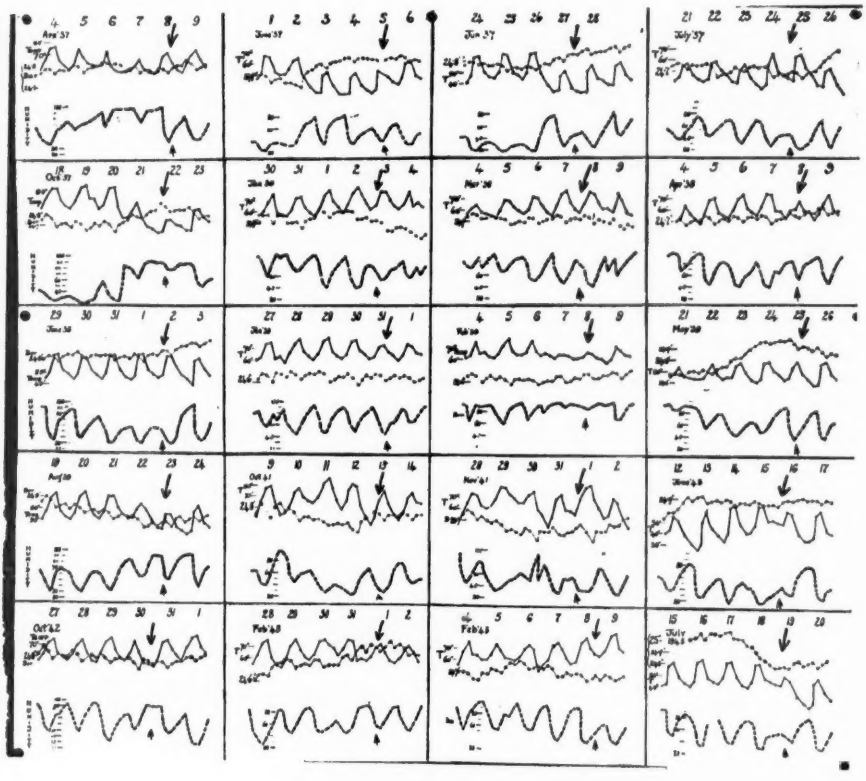

FIG. 2.
Meteorograms of 20 cases of Eclampsia.
Queen Victoria Hospital, Johannesburg, 1937–43.

CONCLUSIONS.

Season in itself does not appear to be associated with eclampsia (Fuestner and Sargent[6]); this is borne out by the figures for antepartum eclampsia in Table II. As far as weather changes are concerned correlation could not be found between the onset of antepartum eclampsia and the meteorological factors studied. Attempts

at statistical analysis of the values for these factors for the day of onset and the 4 or 5 days preceding the attack failed to yield significant results. A study of the charts, revealing the synchronous daily variations in the meteorological events, also failed to show common coincidental changes preceding the attack. The contradictory statements made by different authors further supports the view that some other factor must be sought to explain the onset and incidence of eclampsia, and the greater frequency of the disease in some centres than in others.

Permission to study the records was obtained from Professor E. C. Crichton (University of Cape Town) and Professor J. Black (University of Witwatersrand) to whom thanks are due. Lieut.-Commander S. P. Jackson kindly furnished the meteorological data from which the charts were drawn and gave other valuable assistance.

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BOOK REVIEWS

"The Technical Minutiae of Extended Myomectomy and Ovarian Cystectomy." By VICTOR BONNEY. London: Cassell & Co., 1946. Price 30s. 282 pages.

MOST of us can recall reading at some time the preamble to myomectomy in Berkeley's and Bonney's "Textbook of Gynaecological Surgery," and the lasting delight that its grave and beautiful language and unaffected sensibility gave, so that as the years went by one came to quote the passage again and again as a sort of testament of our common aims. It is no exaggeration to say that at least a whole generation in this country and the Empire owes much of nicety of technique and confidence in strategy to Berkeley's and Bonney's great book, and the few who have been privileged to be taught by Mr. Bonney in person at the height of his powers cannot help but know that they have been fortunate indeed above their contemporaries.

The present book completes very perfectly the Textbook. Bonney is a Teacher. He has simplicity, invention and courage. Not the dry sticks of technical jargon rustle in his writings; his sentences have the true "clangour of bronze" that awakens response and memory. If his object has been to make conservative gynaecological surgery widely practised by making it "easy", it seems to me that he has succeeded. Every difficulty, small or great, that he has encountered since his gangling days is here demonstrated and overcome, although not even this author-artist can describe or depict the gentleness and deftness needed that operations of such extent and duration be safe or indeed possible. This is the one danger of this book. It is perhaps too much to ask that a book on the technical minutiae of such operative procedures as extended myomectomy include a short note on the wise use of plasma- or blood-transfusion, although, in the opinion of the reviewer, this would enhance its worth. For the rest, it is not possible to measure the praise and gratitude that is owing for this fine work or to do other than recommend its constant reading by every gynaecologist who claims, in Mr. Bonney's words, to be one of the "small group of a great host whose marching cry is 'something better'!"

This is an era when a declaration of high purpose is apt to be considered outmoded, immodest or insincere; when it seems to be taken for granted that the mastering impulse in medicine, too, must be wages and hours, a rate for a job. We have seen in our time the tradition of British craftsmanship, such as made our homes and our furniture the delight of the world, decline, and the mass-produced and jerry-built accepted by a public taste too debased for outcry. With schemes of state medicine requiring the mass-production of specialists, with the wastage of the past six years yet unremedied and with a decline of competition and criticism threatening, a debasing of our standards of surgery may truly be feared.

There is to be no time to stand and stare at the great craftsmen at their work and to learn beautiful surgery in leisurely apprenticeship. Therefore, Mr. Bonney's book is our peculiar gain at this moment, and for the future may compare with the drawing-book of Sheraton or the case-books of Smellie as an unmatched exposition of the technical minutiae of art and craft.

MEAVE KENNY.

"A Pocket Obstetrics." By ARTHUR C. H. BELL, M.B., B.S., F.R.C.S., F.R.C.O.G., Hon.M.M.S.A. London: J. & A. Churchill. 148 pages. Price 7s. 6d.

THIS little book is produced in the hope that it will be of help to general practitioners and midwives in their work, and to students for revision purposes. Clearly it is to the last class of reader that it will appeal most. In the busy days before the approaching final examinations a small book which may be carried in the pocket is appreciated by the student. It can be read at odd moments in train, tram or bus. But it must be clear, reasonably full and yet concise, dogmatic but with a discursive element. Its limitations must be obvious so that the reader is driven back to more comprehensive works in order to fill in the gaps. It must not attempt to supplant the textbook. It must come from an authoritative source.

These criteria are satisfied in this publication. The author's authority is unquestioned. The approach and practice professedly largely follow

that of Queen Charlotte's Textbook of Obstetrics, of which Mr. Bell is part author.

It is perhaps surprising to find the Prague seizure advocated in breech delivery, that eggs and onions should be avoided during sulphonamide administration, that Caesarean section should *never* be considered in the treatment of placenta praevia unless the patient is in good condition. That there are, of course, two sides to every question is an undergraduate's dilemma—particularly just before *viva voce*. Because his sense of proportion is not yet developed he magnifies this dilemma, for himself Hence there is a need for sound, acceptable, orthodox teaching. Such the student will find in this little revision book. It can be thoroughly recommended provided it is used for the purpose for which it is written—revision.

The book is well and nicely printed on good paper and attractively bound.

ANTHONY W. PURDIE.

"A Practical Handbook of Midwifery and Gynaecology for Students and Practitioners." By W. F. T. HAULTAIN, O.B.E., *M.C.*, B.A., M.B., Ch.B., F.R.C.P., F.R.C.S., F.R.C.O.G., and CLIFFORD KENNEDY, M.B., Ch.B., F.R.C.S., F.R.C.O.G. London: E. & S. Livingstone, 1946. 3rd. edition, 388 pages, 20s.

THIS book is written with the avowed object of being of use to final year students, younger practitioners and those practitioners returning from the Forces who desire a concise up-to-date presentation of midwifery and gynaecology. In other words it claims to be a short textbook.

The student does not always choose wisely the books he will read on any given subject. For this reason, at the beginning of a course of instruction, many teachers recommend a number of books from which the student may choose, according to his fancy, one or more from which he is bound to profit.

There are many qualities which go to make the good textbook. It must provide the student with sufficient factual knowledge to enable him to pass his professional examination on its subject matter. But it should do more than this. It should help him to understand the subject, it should stimulate him to think and reason (with himself at any rate) about it. It should hint at fields of further study beyond the limits of the book itself to which, fired by the author's enthusiasm, he may turn when the examination goal is passed. Coming too, as it should, from the leaders of a learned profession it should be well written. The true synopsis is another matter altogether. It fulfils a different function and is used in conjunction with a textbook.

This book, in the reviewer's opinion is a cross between a textbook and a synopsis. It is written partly in tabular form and partly in staccato phrases or sentences. There must be few subjects within the student's range of obstetrics and gynaecology which are not mentioned. But it is very sketchy in many places. An example may make this clear. When the authors describe internal rotation in dealing with the mechanism of labour they refer to the work of Sellheim and of Moir. Their description of this is quoted in its entirety: "If a cylindrical body capable of bending on its long axis unequally in different directions is forced through a curved cylindrical passage, it will rotate in such a way as to adapt itself best to that canal and to allow bending to occur with the maximum ease. Internal rotation results in the long diameter of the skull being brought into the long antero-posterior diameter of the outlet." The enquiring student is not likely to be satisfied.

In the section devoted to the uses of X-rays in obstetrics and gynaecology pelvic mensuration and shape are dismissed thus: "When contraction or abnormal shape of the pelvis is suspected, X-ray examination may be most helpful. This applies to the false pelvis and to all levels of the true pelvis." There is no description of this use of X-rays in the chapter on contracted pelvis to justify the paucity of this description.

One could continue to elongate the sketchy and unsatisfactory exposition of many sections. The book will appeal most to the somewhat indifferent student with a good memory. He will be able to combine what he has acquired from good clinical teaching with what he has crammed from this book. He may elude the vigilance of his examiners and be satisfied. But to confine his obstetrical and gynaecological reading to this book will be decidedly to his impoverishment.

ANTHONY W. PURDIE.

ROYAL COLLEGE OF OBSTETRICIANS AND GYNAECOLOGISTS

A meeting of the Council was held in the College House on Saturday, July 27th, 1946, with the President, Mr. Eardley Holland, in the Chair.

Mr. William Gilliatt, C.V.O., M.D., M.S., F.R.C.S., F.R.C.O.G., was elected President to take office in September next.

The following officers were also elected:—

Vice-Presidents:

Robert Marshall Allan, *M.C.*, M.D., F.R.A.C.S., Hon.F.A.C.S., F.R.C.O.G.

Sir William Fletcher Shaw, M.D., F.R.C.P., Hon.F.A.C.S., F.R.C.O.G.

The following candidates were elected to the Membership:

Hugh Rose Arthur.
Samuel James Barr.
Bryce Evans Blair.
Catherine Isobel Blyth.
Joyce Muriel Burt.
Harold Burton.
Guy Beadon Walmsley Fisher.
Brojo Gopal Halder.
Robert Leighton Hartley.
Derek Jefferiss.
Iola Lloyd Trevor Jones.
Leslie Wallace Lauste.
Elizabeth McCallum.
Margaret Orford.
Hedley Charles Perry.
Dwifendra Lal Poddar.
Esther Mary Pollock.
J. Edmund Scott-Carmichael.
William Robert Sloan.
Robert Alexander Russell Taylor.
Eric Wilfred Lowther Thompson.
Thomas George Edward White.

INDEX TO CURRENT LITERATURE

In this Index and endeavour will be made, so far as conditions permit, to maintain an up-to-date record of all titles bearing on obstetrics and gynaecology and the infant. The classification aims at making immediately available for the reader the titles under the various subject headings. In the majority of instances the title is obtained from the original publication. Where this has been impossible, the title has been obtained from the abstracting journal shown in brackets. Reprints will be welcomed and should be sent to the Editor.

Any inquiries should be addressed to Miss D. F. Atkins, British Postgraduate Medical School, Ducane Road, London, W.12.

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ANATOMY

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NORMAL

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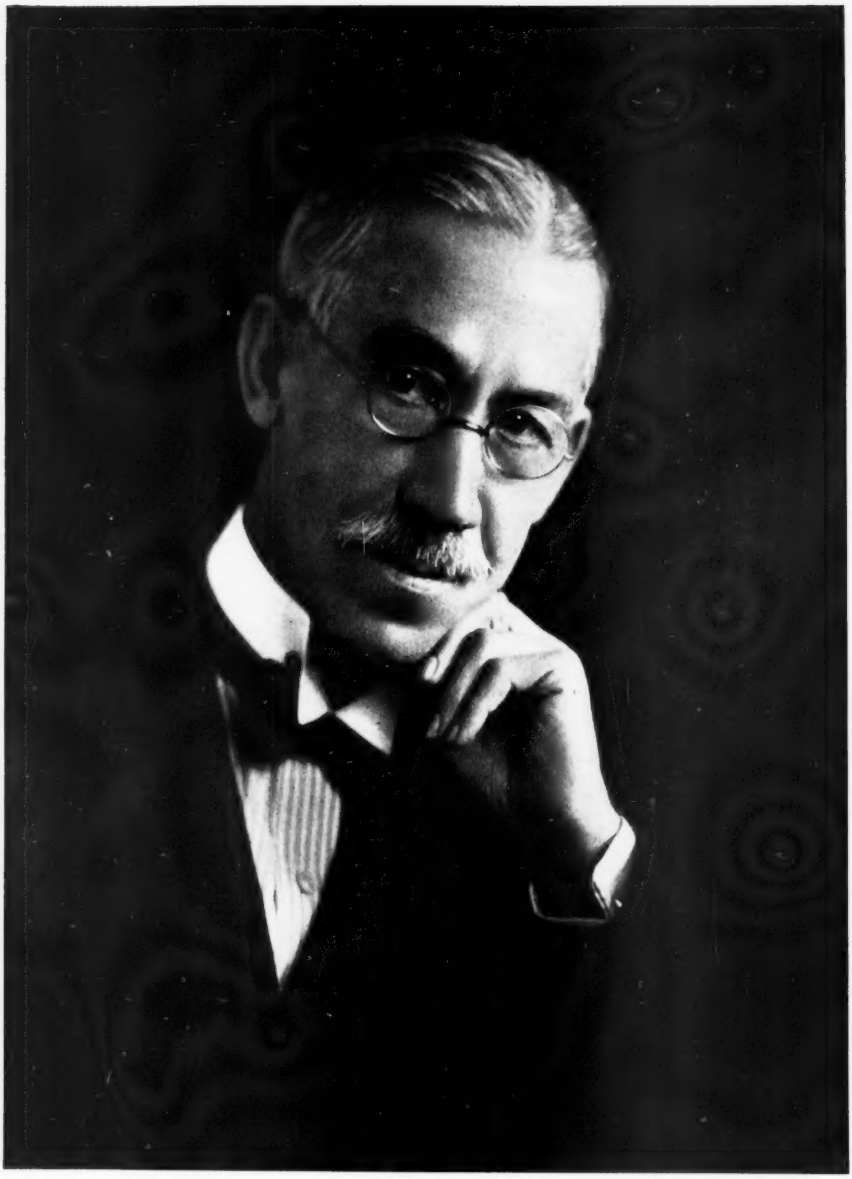

Photo by Lafayette

T. WATTS EDEN

UNIV. OF MICH.

Obituary

T. WATTS EDEN

M.D., F.R.C.P., F.R.C.S., F.R.C.O.G.

Chairman, Board of Directors, The Journal of Obstetrics and Gynaecology of the British Empire Publishing Co., Ltd., 1930–1946.

DR. EDEN'S connexion with our Journal was a long and intimate one. He contributed a characteristic Critical Review to the first volume published in 1902 and thereafter maintained the keenest interest in its progress. He served at various times as a member of the Editorial Committee and edited the Journal for two years, 1904–5.

Having joined the Board of Directors in 1920, he was elected Chairman ten years later and continued in that office until his death. During this long period of sixteen years he guided the policy of the Journal with a sure hand and in taking leave of him and placing on record their appreciation of his services, his colleagues on the Board are very conscious that they have lost a Chairman whom it will be difficult, if not impossible, to replace.

DANIEL DOUGAL

THOMAS WATTS EDEN was born in 1864 the son of Alfred Thomas Eden, of Evesham. He was educated privately and at the University of Edinburgh, where he graduated M.B. in 1888. In his student days he was marked for his piety and his power of rhetoric. He was a brilliant student, gaining many prizes and graduating with first class honours. In addition he gained the much-coveted Ettles Scholarship, awarded to the most distinguished graduate of his year, and the James Scott Scholarship for the greatest proficiency in Midwifery and Gynaecology. He was well-loved by his fellow students and made friendships which continued throughout his life.

In 1889 he was awarded the Leckie Mactier fellowship of Edinburgh University and used this to complete his equipment for a distinguished career by study in London, Berlin, Leipzig and Birmingham. In 1891 he proceeded M.D., again with honours, and later added the Fellowship of the Royal College of Physicians of London and of the Royal College of Surgeons, Edinburgh to his distinctions. He first joined the staff of the Chelsea Hospital for Women in 1898 as a resident surgical officer and later as

assistant surgeon. His first published paper in 1896 was a "Study of the Human Placenta", which attracted considerable notice. He continued to devote all his energies to his speciality and in 1906, when he was on the Staff of Charing Cross Hospital, Queen Charlotte's Hospital, and the Chelsea Hospital for Women, he published his *Manual of Midwifery* and displayed his great gifts as a teacher. Among his colleagues at his three hospitals were such men as Fairbairn, Gow, Comyns Berkeley and Victor Bonny. Teaching was his great love and he attracted many students to his clinic at Charing Cross Hospital.

He was examiner for the Conjoint Board and to the Universities of Oxford, Cambridge, Edinburgh and Leeds, and students recall him as one of the small number of examiners who "teach as they examine." His influence upon medical teaching and the progress of midwifery in this country was therefore great. He was one of the first to preach the concept of labour as a surgical matter than as a medical procedure.

During the first World War he served as a major in the R.A.M.C.

He was concerned in the foundation of the Royal College of Obstetricians and Gynaecologists in 1929, being a Founder Fellow, and Member of the First Council. He was also President of the Section of Obstetrics and Gynaecology of the Royal Society of Medicine, and in 1930 became President of the Royal Society of Medicine itself, being only the second obstetrician to fill this position since the inception of the Society.

He also served on the Governing Body of the British Postgraduate Medical School. At the time of its foundation in 1935, as a member of the Joint Council of the National Birthday Trust, he was one of the committee which in that year drew up a scheme for a National Midwives Service designed to improve the status and training of the midwife.

Dr. Eden's best known work is his *Manual of Midwifery*, which has gone through seven editions. In 1911 he wrote a *Manual of Gynaecology* and in 1916, in collaboration with Mr. Cuthbert Lockyer, his colleague at the Charing Cross Hospital, he wrote the monumental *Gynaecology for Students and Practitioners* which went to four editions.

Early in its career, he became a Director of *The Journal of Obstetrics and Gynaecology* of the British Empire, and continued to serve it as Chairman of the Editorial Committee until the time of his death.

Until the end of his life, although in retirement in Devon, he continued to serve the ideals of his profession on many committees, bringing to his work, dignity, moral courage, integrity and profound commonsense which commanded the respect and affection of all who worked with him.

His modesty and wisdom were reflected in his writings and his life, and his death leaves a sad gap in the affections of his many friends and colleagues.

In 1900 Dr. Eden married Miss May Bain of Cockermouth, who survives him.

J. Y.